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ABSTRACT

Consituting the first full treatment of computers in reading, this volume focuses on recent develcpments in computer assisted instruction and its classroom implications. The eight chapters provide information on the following topics: the development of digital computers and of programs for using them for educational purposes, college centers developing computer based reading programs, public school applications of computers to reading instruction, computer assessment of readability and textbook analysis, sources of computer services, recommended uses of computers in the reading program, computers in reading research, and the future of the computer as an aid to reading instruction. Extensive annotated references are provided for each chapter. (FL)

COMPUTER APPLICATIONS IN READING

by

George E. Mason and Jay S. Blanchard

University of Georgia

International Reading Association
800 Barksdale Road
Newark, Delaware

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Foreword

With the publication of this volume, the International Reading Association welcomes to its list of service publications the first full treatment of computers in reading. Some might argue that this work is long overdue. After all, computers have been used in instructional experiments for over twenty years and in reading research for even longer. On the other hand, one could just as convincingly contend that this work is premature. The recently arrived minicomputer, just now finding comfortable lodging in the schoolhouse, is threatened with obsolescence by the microcomputer and the hand-held calculator, which now talk, give spelling quizzes, translate foreign language vocabularies, and even burp up melodies for ear training. The rate of change in both hardware and courseware is so rapid that before the evaluation data for any one instructional experiment are digested, a totally new system is ready for tryout. Such, unfortunately, is already the fate of the massive NSF-sponsored evaluations of the TICCIT and PLATO systems, evaluations begun in 1972 but not yet fully reported. Meanwhile, the computer systems which were involved have changed so dramatically that the hardware and courseware findings of these studies will have little more than historic interest.

Nevertheless, the evidence from these studies and from others now available (particularly from Canadian experiments) shows that the potential for efficient and cost-effective utilization of computers in reading instruction merits the same seriousness and precision of assessment that is applied to the evaluation of other instructional innovations. This is not claim that computers are a proven classroom resource. As a universal fix for reading ailments, they rank no higher than jumping jacks, eye-movement pacers, and frontal lobotomies. But computers have risen above the level of technological curiosities. From the development projects and school implementations reported here, one can rapidly establish that the utilization of computers in reading instruction is no longer foolishly aimed toward the replacement of the teacher but, instead, toward the addition of rapid-response, high-volume data processing capabilities to the arsenal of resources from which educators can draw.

The question is no longer "Can computers teach?" Instead, it is "Under what circumstances can computers be incorporated into the instructional process?" For many circumstances, the answer is still probably "none." But the usability of computers is rapidly improving, especially with the steep decline in hardware prices and the steady

movement toward true user-oriented software. And, as more and more school systems experiment with computer aided and computer managed instruction, our understanding of the true capabilities and limitations of computers increases. The major contribution of this volume is to focus on those developments and implementations from which we can gain valuable assessment data. In a rapidly changing world, the current status of a technology may be far less important than the application of that technology in a manner that produces usable data for its improvement.

Richard L. Venezky
University of Delaware

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The information within this book was gathered between late 1976 and early 1978. Because of the constant research and development in computer hardware and in computer based instruction, it has been impossible to include all of the very recent reports. We are aware of a number of ongoing projects which have been reported at very recent conferences and in recent journals. We also are aware that we may have omitted valuable work which somehow escaped our attention. We hope that readers will help us to compensate for our errors (both of omission and commission) by writing and sharing their knowledge with us.

GEM and JSB

Chapter 1

INTRODUCTION

The Development of Digital Computers

Large Central Processors

The first completely electronic computer, ENIAC, was developed at the University of Pennsylvania in 1945. It had 18,000 vacuum tubes. The heat generated by the tubes and the constant need for replacing worn out tubes made this and other early computers of little value to education or industry. However, the invention of the transistor in 1947 enabled computer engineers to reduce heat problems and to nearly eliminate tube replacement problems. Successes led to commercial production and sale of a variety of computers which have constantly increased in the complexity of function they perform.

The computers which have come to be used in education are digital computers. Their transistors are operated as switches that generally have only two states: on or off (conducting or nonconducting). The signals switched on or off are only two: high or low voltage. Since all the states in a digital circuit are one or the other of these dual values, the logic or arithmetic of a digital computer operates with a binary (base 2) number system. In a binary system, digits represent (from right to left) ones, twos, fours, and eights instead of ones, tens, hundreds, and thousands (i.e. to a computer 001 = 1, 010 = 2, 011 = 3, 100 = 4, and 1011 = 8 + 0 + 2 + 1 = 11). The binary system can be used not only for adding, subtracting, multiplying, and dividing but also for evaluating logic statements. The binary values of on/off, high/low voltage or 1/0 can be made to stand for true/false or yes/no. This system is what gives the computer its tremendous potential.

Even with this great potential, the transistorized digital computer did not come into wide use until the development of the integrated circuit at Fairchild Semiconductor in 1949. (Integrated circuits are

printed or etched onto very small disks or squares of silica. Already, integrated circuits have replaced mechanical elements of the calculator and the watch.) As a result of the price reductions which followed the development of integrated circuits, computers became common in colleges, universities, large school systems, government institutions, and large corporations. Yet, since they were still very expensive and very complicated to own and operate, smaller organizations seldom could afford them. The large computer centers used powerful CPUs (Central Processing Units). In the early 1970s, the most commonly used were the CDC 6400 and 6600 (from Control Data Corporation), the IBM 360/40-50-67 and IBM 370 (from International Business Machines), the UNIVAC 1108 (from Sperry Univac), the GE 635-645 (from General Electric) and the Spectra 70 (from RCA).

The Development of Data Processing Languages

To make computers useful for the wide variety of large scale users, programs (sets of rules) had to be developed for converting typed-in commands or sequences of activities to the "machine language" of the computer (on/off, high/low voltage, or 1/0). These programs are called data processing languages, or "author languages." By 1969 at least 60 of these author languages had been developed.

These languages can be divided into four classes, according to their potential for instruction: 1) Description of successive frames or items, 2) provision (within a limited context) for conversation, 3) specification of a standard method of presenting content, and 4) detailing the conditions for program construction.

The first of these categories includes more than 20 languages. Those which the reading specialist is most likely to encounter are "Coursewriter II" and "TUTOR." These languages are "conversations." They do well at presenting written text, at correcting "open answers" (those not chosen from a multiple-option set), at recording the answers of various kinds and type, and at branching determined by answers or sets of answers.

In the second group are languages which have the characteristics of those in the first group, but which can simulate a conversation between the student and the program only within a limited context. Among those in this group are FIT, ELIZA, FOIL, MENTOR, MINORCA, GLURP, and PLANIT. (The last four of these could be listed in the first group.)

The third group includes CATO, XXX, TICCIT, and PICO (a French author language). In the languages of this group, a system of pro-

graming procedures is required. The user has no choice but to follow them. These languages are generally used for computer managed instruction. In this group are IMS (Information and Management System) of the Southwest Regional Education Laboratory and Systems Development Corporation; PLAN (Program for Learning in Accordance with Needs) of the American Institutes for Research and the Westinghouse Learning Corporation; and WIS/SIM (Wisconsin System for Information Management) of the University of Wisconsin's Center for Educational Research and Development and the National Computer Systems Company.

In the fourth group of author languages are those which specify the conditions or limits for program construction. Most of these were not intended to be used in instruction, but several were immediately so used (for teaching and learning). Of those intended to be used for instruction, the best known are LOGO and BASIC. Both are very easy to use and may be applied even by elementary school pupils, who can use them to program the computer to solve a variety of problems. BASIC (Beginner's All-purpose Symbolic Instruction Code), the first interactive language created for instructional purposes, was developed in 1966 at Dartmouth College.

As more and more computer centers were created in universities and other large organizations, a few of these became very popular and others disappeared. By 1973 the most popular languages were COURSEWRITER II, APL (A Programing Language—the IBM calculating language), and BASIC. Very popular, but less frequently used, were TUTOR and FORTRAN. By 1978 BASIC had come to be the major author language.

Newer Developments in Computers and Computer Use

When computers were first being used for instruction, each could operate only one terminal at a time. Project PLATO, at the University of Illinois, started in 1960 with an Illiac I which served only one terminal, and the PDP-1 with which the Stanford project started in 1963 served only six stations, none of which was more than 100 feet away. However, it was eventually connected to 600 teletype terminals in Mississippi, 800 in Kentucky, and 900 in California. By 1968, 6,000 New York City pupils were receiving computer assisted instruction processed by one RCA Spectra 70/45 located at 42 Street and Second Avenue. The sharing of one computer by a number of terminals was a very important development. The devices which allow such sharing of on-line time among

computer users are called interfaces. With interfaces, the CDC 6400 at Illinois is one day expected to be able to handle 4,096 terminals on a time sharing basis.

Another important development was the formation of user groups. Some user groups such as TIES (a group of Minnesota High Schools), the Montreal Catholic School Commission, and the Northeast Ohio Computer Network actually share one computer. Others, such as EDUCOM, ARPA, CONDUIT, and CANUNET (Canadian), are groups of colleges which share computer based courses and other software. Furthermore, most computer manufacturers sponsor a user's group, which they have organized to facilitate sharing of computer courses, programs, and innovative uses by owners of the hardware (computing equipment) manufactured by that company.

Even as these groups were being formed, however, computer technology was taking another leap forward with the development of minicomputers ($10,000-$30,000). These are flexible and programable (but not portable) with direct access memory channels for storing information fed in by the user. Those most often used in teaching are the GE 255-235, the IBM 1130 and the HP 2000 (of Hewlett Packard), and the PDP-8 (of Digital Equipment Corporation). With these smaller computers, many high schools and vocational technical schools began to teach computer programing as an optional course in their mathematics sequence and to make available to their students both programs and courses developed in school, as well as predeveloped programs purchased from a commercial company or borrowed from another member of their user's group.

Schools and colleges operating the smaller computers frequently arrange interconnections with operators of large computers. The Georgia State Board of Regents Network is an example of such a network of computers. This network allows the smaller local computers to become terminals for the largest in the system when its capabilities are desired.

The capabilities of the smaller computers were not vastly different than those of the older large computers. In fact, many of the newer minicomputers have more power than the larger machines which were their predecessors. (The power of these computers is based on the number of bits [or digits] that it can process, with one circuit required for each bit. The number of bits also determines how many memory circuits can be accessed [i.e. a four-bit processor can access 15 locations, since there are only 15 binary numbers of four bits or less, while a 16-bit processor can access 65,536 memory bits]. The size of a computer

memory is usually described in Ks or thousands of bits. A byte is eight or nine bits).

Even as individual schools began purchasing minicomputers, the four-bit microprocessor (MPU) was invented by personnel of the Intel Corporation in 1971. The microprocessor contains the most important circuits of a computer and is the size of a postage stamp. By 1973, more than 10,000 transistors could be integrated on a single silicon chip smaller than a postage stamp. In 1976, an 8-bit microprocessor was fabricated on a single chip which contained more than 20,000 transistors. As a result, microprocessor memory size is now specified in thousands (Ks) of bytes or characters rather than in bits.

The advent of microprocessors has been followed by the creation of a flood of very small portable computers, suitable not only for school use but also for home use. Most of these contain some random access memory (RAM) circuits for programing by the user, while nearly all have read-only memory (ROM) circuits preprogramed to hold the BASIC language and some computer games and/or mathematics drill and practice programs. To date, none have been preprogramed with stored reading instruction. However, they are bound to have an impact and what that impact may be will be discussed in the final chapter of this book.

The second chapter describes the colleges where reading programs were created—initially on the large expensive computers, later with interfaces and networks and, most recently, with minicomputers. The third chapter describes public school use of computers for reading instruction. The fourth details computerized readability assessment efforts, the fifth reports computer services in reading that are available to schools. The sixth annotates reports of research on teaching and learning reading with the aid of the computer. The seventh relates suggested uses of the computer in reading instruction, and the eighth predicts the future for computer based reading instruction.

Annotated References

1. Albrecht, B. *Teach yourself* BASIC. San Carlos, California: Technica Education Corporation, 1970.
   A two volume worktext for self-teaching of the BASIC author language. Includes practice exercises to do at the terminal.
2. Northwest Regional Education Laboratory. *REACT Relevant educational applications of computer technology*. San Carlos, California: Technica Education Corporation, 1971.
   Course I is composed of ten worktexts designed to give teachers and administrators a survey of the development of computers, kinds of computers, man-machine languages, author languages, instructions

for using teletype terminals and two types of computers, and the use of computers for direct instruction and computer managed instruction.

Course II for teachers consists of six worktexts in which are listed and described the REACT programs developed at the Northwest Regional Education Laboratory. Included are programs in business education, English (poetry only), mathematics, science, and social studies. Course II for principals consists of eight booklets describing uses of the computer in record keeping and school management.

3. Noyce, R.N. Microelectronics. *Scientific American*, 1977, *237* (3), 63-69.

Discusses the evaluation of microelectronic devices since the development of the transistor, pointing out that a $300 minicomputer of today has more calculating power than ENIAC, the first electronic computer.

4. PLANIT: *A computer assisted instruction language system.* Portland: Northwest Regional Educational Laboratory, n.d. (mimeo).

Gives history of involvement of Michigan State University, Systems Development Corporation, and NWREL in developing PLANIT, which is briefly explained. Reference is made to a PLANIT user's group.

5. Zinn, K.L. *Computers in the instructional process: Report of an international school.* Ann Arbor: Center for Research on Learning and Teaching, University of Michigan, 1974.

Describes and classifies a large number of author languages, relating their general utility.

Additional References

6. Association for Educational Data Systems. *Layman's guide to the use of computers.* Washington, D.C.: The Association, 1971.
7. Charp, S. *Computers in general education.* Harrisburg: Pennsylvania Department of Public Instruction, 1967.
8. Goodman, L.L. *Man and automation.* New York: Penguin Books, 1957.
9. Greenberger, M. (Ed.). *Computers and the world of the future.* Cambridge, Massachusetts: MIT Press, 1962.
10. Toong, H-M.D. Microprocessors. *Scientific American*, 1977, *237* (3), 146-147, 151-156, 158, 160-161.
11. Vacroux, A.G. Microcomputers. *Scientific American*, 1974, *232*, (5), 32-40.
12. *What is binary arithmetic?* Dayton, Ohio: National Cash Register, n.d.

The Programs Developed

As computer technology developed more complicated, faster, and yet cheaper equipment, programs for using computers for educational purposes were also being developed. The principal uses were computer assisted instruction (CAI) and computer managed instruction (CMI).

Computer assisted instruction is a term used to describe any instruction in which the material to be learned is presented by equipment under digital computer control and in which the students' responses are relayed to the computer for processing. The processing of responses generally includes storage of the responses in the computer's memory system, decision making as to reinforcement, and decision making as to the appropriate next presentation.

Typically, the presentation is a display on a cathode ray (television picture) tube or a plasma panel. Such displays can be printed text, graphed or charted material, and photographs or drawings in color or black and white. Less frequently the presentation is auditory, since groupings of recorded speech sounds are unlikely to produce words pronounced appropriately for the context of meaning intended.

The responses elicited are most frequently to be made with a keyset resembling a typewriter. The students type in the letters A, B, C, D, or E to indicate their choices for multiple-choice questions or they type in Yes, No, True, False, or missing terms in incomplete statements. For young children only a few of the keys may be employed or a special key set using smiling faces or geometric designs may be used. As an alternative for young children, a light-sensitive cathode ray tube can be employed. Students using it point a light pencil at targets presented on the screen to indicate their responses. Even younger children can respond to the touch-sensitive panel which may be attached to Plato terminals. Plasma panels permit simultaneous display of machine controlled graphics and rear screen projected random access slides from microfiche.

Computer assisted instruction is generally programed instruction. Students are presented stimuli to which they respond at their own rate. Responses can be immediately confirmed by computer presented words or symbols, although in some cases a number of responses are expected before computer acknowledgement.

The programs of instruction available are of three types differing in complexity and in the amount of student-system interaction: *tutorial* programs which are self-contained courses of instruction with machine decisions and branching; simple linear *drill and practice* programs

which are designed to supplement instruction initiated by a teacher; and *dialogue* programs which enable learners to converse with the computer in natural language wherein the student controls the information sequence. These programs are developed by educators or psychologists who direct the computer's activities using an author language.

Students can learn to use computer terminals with help from the teacher or another student. Usually very little help is required, even by elementary school children. Two or three ten-minute sessions are usually sufficient, even when audio disks and/or microfiche must be loaded. In some school systems, such as the Clarke County, Georgia, Schools, children belonging to the TAGS (Talented and Gifted) organization may elect to enroll in Saturday classes at a nearby college or university where they learn to solve problems by doing simple programing of the university computer in the BASIC language.

Computer managed instruction usually does not require that the student learn to operate the computer terminal. Instead, teachers give children criterion referenced tests to which the children respond by marking on machine-scorable answer sheets. These are mailed or shipped to the computer serving the school or college for batch-processing. Printouts are generated for the child, and class records are made up for the teacher. Some of these printouts may include individual prescriptions complete with materials and recommended pages for practice.

Progress in the development of both CAI and CMI programs is described in the annotated references in the final section of this chapter. Several additional references are listed at the end for reading specialists who desire to add depth to their knowledge in this area.

Annotated References

13. Association for Development of Computer Instructional Systems (ADCIS). *Minutes and proceedings of the semiannual meeting*. Ann Arbor, Michigan: August 1973.

Abstracts are included of 23 reports given at the conference. Many deal with computer based instruction projects, including some in reading.

14. Baker, F.B. Computer based instructional management systems: A first look. *Review of Educational Research*, 1971, *41* (1), 41-70.

Describes computer based instructional management systems existing in 1971. It is a complete review of early CMI programs and some CAI programs are mentioned. The author hypothesizes that computer based instructional management has greater possibilities than computer assisted instruction because of costs.

15. Baker, J.C. *The computer in the school* (Fastback number 58). Bloomington, Indiana: Phi Delta Kappan Educational Foundation, 1975.
A pamphlet giving an overview of computer assisted and computer managed instruction. It includes information on the following programs: PLATO, TICCIT, LOGO, and PLAN. Also included are the author's opinions on present and future capabilities of computers in education.

16. Barnes, D.O. & Schrieber, D.B. *Computer assisted instruction: A selected bibliography*. Washington, D.C.: Association for Educational Communications and Technology, 1972 (ED 063 769).
The most extensive and complete bibliography of computer uses in education and instruction. It contains 835 entries.

17. Beard, M. *Computer assisted instruction: The best of ERIC, 1973-May 1976*. Palo Alto, California: Stanford University. 1976 (ED 125 608).
An annotated bibliography containing articles about the entire spectrum of computer assisted and managed instruction. Included are such topics as PLATO, TICCIT, research, teacher training, author languages and costs.

18. Bukoski, W.J., & Korotkin, A.L. *Computer activities in secondary education: Final report*. Washington, D.C.: American Institute for Research in the Behavioral Sciences, September 1975.
This report is a follow-up to a 1969 project entitled CASE. CASE surveyed secondary public schools to determine computer usage. The current project, sponsored by the National Science Foundation, surveyed 5,580 schools. The contents describe many new secondary computer based programs, with some in reading.

19. Bukoski, W.J., & Korotkin, A.L. Computer activities in secondary education. *Educational Technology*, 1976, *16* (1), 9-22.
This report deals with a survey initiated to determine the extent of computer usage (more than 13 per cent) in secondary public schools. Several secondary public school reading programs are reviewed and a large amount of information about computer availability in secondary schools is included.

20. Bundy, R. Computer assisted instruction—Where are we? *Phi Delta Kappan*, 1968, *49* (9), 424-429.
This article is an overview of the status of computer assisted instruction. The author provides a brief summary of results from research and several recommendations about areas in which further research is needed. He also reviews the research limitations of past projects and comments on the future of computer assisted instruction.

21. Clark. R.F. *The best of ERIC—Recent trends in computer assisted instruction*. Palo Alto, California: Stanford University, 1973. (ED 076 025).
This is an annotated bibliography which covers planning and utilization of CAI. Also included are reviews of computer assisted instruction programs at the elementary, secondary, junior college, community college, and university level.

22. Chevalier, G. *Classification of the uses of computers in education*. Service de l' Informatique. Ministere de l' Education, Laboratoire de Pedagogie Informatique. Province de Quebec. Canada, 1972.

The author reviews the computer in four roles: as a laboratory tool, a teaching support system, teaching system/learning system, and as an educational research tool.

23. Dick, W.; Latsa, R.; & Rivers, L. Sources of information on computer assisted instruction. *Educational Technology*, 1970, *10* (3), 165-169.
The authors surveyed public schools, universities, and research and development centers in 1969 to determine the extent of computer assisted instruction. Several research and development center reading programs are mentioned as well as computer assisted reading instruction in public schools and universities.

24. Dirr, P.J. *Computers in education: A bibliography for the instructional technology course for teachers.* Buffalo, New York: State University College at Buffalo, 1974. (ED 105 677)
The bibliography lists 78 references from 1968 to 1974 on the uses of computers in education. Many articles mentioned deal with reading.

25. Doublier, R.M. *Interactive relationship with computers in teaching reading.* Paper presented at the annual conference of the International Reading Association, New Orleans, May 1974.
The paper reviews current man/machine communications and discusses a computer assisted reading educational system (CARES). The author also proposes CARES as a model for a reading laboratory.

26. Feldhusen, J.F.; & Szabo, M. A review of developments in computer assisted instruction. *Educational Technology*, 1970, *10* (3), 90-97.
The authors alert the reader to potential sources of information available about computer assisted instruction.

27. Fletcher, J.D. *Computer applications in education and training: Status and trends.* San Diego, California: Navy Personnel Research and Development Center, 1975. (ED 108 681).
While this review concerns itself with computer based applications to training, some reading programs mentioned are: PLATO IV, Chicago Public Schools, TICCIT, Stanford University, Florida State University, Pennsylvania State University, and the University of California.

28. Fry, E. *Programed instruction and automation in beginning reading.* Paper presented at the annual conference of the International Reading Association, Seattle, May 1967.
A review of recent investigations into the effectiveness of programed instruction in reading. Included in one aspect of programed instruction is computer assisted instruction in reading.

29. Grayson, L.P., & Robbins, J.B. *U.S. Office of Education support of computer activities: 1965-1971.* (Report No. DE 12044-71). Washington, D.C.: U.S. Government Printing Office, 1972.
This report discusses 500 projects including reading projects and the $161 million spent on computer activities in education between 1965-1971. Unfortunately, follow up documents have never been produced. The report is summarized in the November 1971 issue of *Educational Technology.*

30. Halley, F.S. *Computer applications in teaching and learning.* Brockport, New York: State University of New York at Brockport, October 1973.

Gives examples of computer uses in teaching and learning with particular emphasis on testing.

31. Hickey, A.E. (Ed.) *Computer assisted instruction: A survey of the literature* (Vol. 3). Newburyport, Massachusetts: ENTELEK, 1968.
The survey contains an overview of computer assisted instruction from 1967-1968. Also included are programs in selected curricula (reading) and a listing of public and private computer assisted instruction programs as well as pertinent information about computer assisted instruction theory. An earlier second edition is also available covering 1966-1967.

32. Hickey, A.E. *Research guidelines for computer assisted instruction.* Newburyport, Massachusetts: A.E. Hickey Associates, 1974.
This is a survey prepared for the Defense Advanced Research Project Agency. It contains 59 recommendations for research and development in support of computer assisted instruction. Also covered are learning and instructional variables relevant to CAI and reading.

33. Hicks, B.L., & Hunka, S. *The teacher and the computer.* Philadelphia: W.B. Saunders, 1972.
Reviews the essential elements of computer based and computer assisted instruction programs. The authors also discuss, in depth, basic assumptions about CAI in the classroom.

34. Koch, W.J. *The use of computer instruction in secondary schools.* Washington, D.C.: National Association of Secondary School Principals, 1972. (Reprinted in *Education Digest*, 1973, *38*, 28-31.)
The booklet contains information about the following areas of computer assisted instruction: 1) hardware and software availability, 2) personnel needed, 3) reviews of ongoing CAI/CMI projects, and 4) a glossary of terms.

35. Majer, K. Computer assisted instruction and reading. *Viewpoints*, 1972, *48* (5), 77-97.
A comprehensive review of the development of CAI in reading. The author discusses the following questions: Can CAI be used effectively for reading? How do children respond to reading programs using CAI? What theoretical positions have been utilized with reading programs? What are the advantages of CAI programs? What are the new roles for teachers and the implications for teacher training with CAI? What about cost? What about the future of CAI in reading? A list of references is included.

36. Majer, K. Computer assisted instruction and reading: How, what, when, and where? *Educational Technology*, 1973, *13* (9), 23-26.
This article discusses where computer assisted instruction is being used, the advantages of computer assisted reading programs over other programs, student responses to computer assisted instruction, and the future of computer assisted instruction.

37. Mitzel, H.E. (Ed.) *An examination of the short range potential of computer managed instruction.* Proceedings of a Conference Sponsored by the National Institute of Education, Washington, D.C. (Chicago, November 1974.)

These proceedings are of particular interest to those educators concerned with computer managed instruction in reading. The abstracts include summaries of 27 operational computer managed instruction systems. A few are: PLAN, ISS (Instructional Support System), CISS (Computerized Instructional Support System), and CAM (Comprehensive Achievement Monitoring). Bibliographies included with most abstracts provide access to additional information.

38. Vinsonhaler, J.F., & Bass, R.K. A summary of ten major studies on CAI drill and practice. *Educational Technology*, 1972, *12* (7), 29-32.
The authors summarize the results of ten computer assisted programs of instruction. Reading related programs reviewed are: 1) Stanford—East Palo Alto, California; 2) INDICOM—Pontiac, Michigan; and 3) Harcourt Brace Jovanovich—New York City.

39. *Report on the instructional use of the computer* (3 vols.) Service de l' Informatique. Ministere de l' Education, Laboratoire de Pedagogie Informatique, Province de Quebec, Canada, 1973.
This report contains three volumes. The first, by Guy Chevalier and Bernard Gateau, is entitled "Types of Uses." It classifies and describes the types of instructional uses of the computer including public and private CAI/CMI programs. The second, by Francois Labrousse, discusses the costs of CAI/CMI programs. The third, by Lucien Dube, describes the extent to which computers were/are being used in education.

40. Wang, A.C. (Ed.). *Index to computer based learning* (1976 edition). Milwaukee: University of Wisconsin, Instructional Media Laboratory, 1976.
A complete guide to computer applications in education, especially CAI, it contains 1,837 separate entries. The index details voluntarily reported information about as many computer based projects as possible.

41. Yonder, W.W. *Computer literature bibliography: 1946 to 1963.* Washington, D.C.: National Bureau of Standards, Department of Commerce, Institute for Applied Technology, 1965.
Contains 6,100 references on computer literature from 1946 to 1963.

42. Yonder, W.W. *Computer literature bibliography: Volume 2, 1964-1967.* Washington, D.C.: National Bureau of Standards, Department of Commerce, Institute for Applied Technology, 1968.
Contains 5,200 references from 1964-1967.

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Chapter 2

COLLEGE CENTERS DEVELOPING COMPUTER BASED READING PROGRAMS

The vast majority of the programs for computer assisted instruction and many of the programs for computer managed instruction were developed on the campuses of colleges and universities with the aid of funding from the federal government and from private foundations. Many of the development projects were partnership arrangements in which computer manufacturers worked with the college and university personnel. In such partnerships, instructional program needs led to changes in computer construction and new developments in computer technology led to changes in educational programing.

These projects developed programs, many of which were field tested in public and private elementary and secondary schools. Such programs were modified to meet the demands of in-school operation and to continue operation with the minimal financing available for large scale, in-school, computer based education. Consequently, although the names of colleges and universities are used to organize the developmental efforts described in this chapter, the work was actually carried on by educators and programers from many backgrounds and fields of employment.

Stanford's Institute for Mathematical Studies in Social Sciences

The reading program at Stanford was developed by Atkinson and others over a period of years starting with a USOE grant awarded in 1964. The original program was intended to be a total curriculum which was independent of human teachers.

There were two major problems. No programed curriculum in reading was available for computerized delivery, and no integrated CAI system had been developed and marketed by any one manufacturer.

n 1964 and 1967 both problems were solved in a parallel effort
nford and IBM.
ıe resulting system, the IBM 1800/1500, consisted of a central
ter with disk storage, two proctor stations, and an interphase to
ninals. Terminal equipment consisted of a high speed rearview
p, typewriter keyboard, and an audiotape system delivering
h earphones messages varying in length from a few seconds to
minutes.
ing this system, Atkinson and his associates created a beginning
; program ("tutorial beginning reading program") in which
s responded to video, audio, and rear screen projected displays
ting the light pencil at the screen. The response was evaluated
omputer decision determined the next material to be presented.
erphase allowed the computer, with its ultrafast response capa-
, to serve 16 students in serial order so rapidly that it seemed to
ıat all were being individually served. (This is now standard
e in computer terminal allocation and is called time-sharing.)
ıe student terminals and the tutorial reading program were tried
rst graders from November 1966 to June 1967. During October
met the adults who were to help them learn to use the terminals.
t week in October and the first two weeks in November were used
h pupils to use the terminals. An adult proctor sat by them during
rst five on-line sessions. At first students were allowed only a
nutes' work at the 16 terminals supervised by two student proc-
ıd one machine proctor but, after six weeks, the time was in-
l to twenty minutes daily and by the end of the school year they
llowed half an hour daily. Evening hours were used for curric-
ırogram debugging and early morning hours were for audio and
assembly work.
ior to starting CAI instruction the children had been taught to
d to the written words YES and NO and to written forms of their
ames. With this background they were able to walk into the
al room, find the cathode ray tube showing their own names,
their earphones, and start the program by touching the light pen
display. Children soon learned to read "You have signed off,"
was presented at the end of each day's lesson.
ıe curriculum presented six kinds of reading tasks to the students:
liscrimination and identification, initial vocabulary, word de-
, syntactic and intonation practice, syntactic and semantic
e, and informational processing tasks.

n 1964 and 1967 both problems were solved in a parallel effort
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ırogram debugging and early morning hours were for audio and
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ior to starting CAI instruction the children had been taught to
d to the written words YES and NO and to written forms of their
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al room, find the cathode ray tube showing their own names,

the student was working on in each of the strands, and his error rates. The same information was available for the class as a whole and for class averages.

An experimental comparison of the reading scores of students whose instruction was supplemented with twelve minutes per day of computerized reading instruction found the experimental students to have reading norm scores 1.2 years greater than those of their controls. The cost of this difference was estimated to be 40 cents per day or $70 per year. Even though the research on CAI in elementary reading has now been terminated, and children in schools around Stanford no longer sit at computer terminals, much of the knowledge gained has been of use in ongoing programs, such as those used at schools for the deaf and those marketed commercially.

Annotated References

49. Atkinson, R.C., & Hansen, D. Computer assisted instruction in initial reading: The Stanford Project. *Reading Research Quarterly*, 1966, 2 5-25.
    A description of the purposes of the CAI Reading Project, its organization, its potentials for research, the equipment to be used, and what commands were necessary to create one complete lesson. Also explained is the six strand reading curriculum.

50. Rodgers, T.S. *Linguistic Considerations in the design of the Stanford computer based curriculum in initial reading*. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1967.
    Seven tenets of psycholinguists form the base for the curriculum in initial reading: 1) spelling and reading were to be taught independently; 2) reading was to be begun with decoding; 3) sight and sound were to be associated with letter patterns; 4) vocalic center groups were to be scaled in difficulty for presentation; 5) graphic patterns were to be presented as members of a rhyme and alliterative set in matrix format; 6) word items were to be presented in various contexts emphasizing morphological syntactic and semantic functions; and 7) words were to be presented in contexts in which punctuation, grammar, and meaning conveyed the writer's intent.

51. Atkinson, R.C. *Instruction in initial reading under computer control*. Stanford, California: Institute for Mathematical Studies in the Social Studies, 1967.
    Explains the presentation of reading instruction to beginners by computer. Sixteen children could be taught at one time. Extensive "debugging" of the program was one of the first requirements in implementing the computer controlled tape-filmstrip instructional program.

52. Wilson, H.A., & Atkinson, R.C. *Computer based instruction in initial reading: A progress report on the Stanford Project*. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1967.
    Describes development and initial field testing of the first grade

tutorial program in reading. Students responded to computer presented auditory and visual stimuli with light pens. Points out the tremendous number of coursewriter commands necessary to execute a typical 30-minute student lesson.

53. Spache, G.D. A reaction to computer assisted instruction in initial reading: The Stanford Project. *Reading Research Quarterly*, 1967, *3* (1), 101-110.

An evaluation of reference 49 listing six misconceptions said by Spache to be held by Atkinson and Hansen and pointing out that they ignored learner variables and employed questionable output variables in their research.

54. Atkinson, R.C., & Suppes. P. *Project for an automated primary grade reading and arithmetic curriculum for culturally deprived children: Progress Report Number 5.* Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1967.

Describes how students began to "spread out" through the various levels of the program's reading exercises and problems.

55. Atkinson, R.C. *Computerized instruction and the learning process. Technical Report Number 122.* Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1967.

Explains the use of the cathode ray tube and light pencil as well as relating problems in implementing the curriculum.

56. Sear, P.S., & Feldman, D.N. *Changes in young children's classroom behavior after a year of computer assisted instruction: An exploratory study.* Stanford, California: Institute for Mathematical Research in the Social Sciences, 1968.

Observations resulted in comparison of behavior ratings on CAI-taught and non-CAI-taught first graders. Social behavior scores of CAI group decreased, while those of the non-CAI group increased. It was posited that CAI may reduce the expected positive relations among academic behavior, IQ, and achievement.

57. Jerman, M. Promising developments in computer assisted instruction. *Educational Technology*, 1969, *9* (8), 10-18.

Explains how audio messages were digitized and stored for computer retrieval and use in the initial reading program.

58. Suppes, P. *Computer assisted instruction at Stanford.* Proceedings of an International Conference of Man and Computer, Bordeaux, 1970.

A history of the Stanford CAI project which provides an excellent description of the equipment used by the project and a year-by-year accounting of the schools involved with the project's various curricula. Finally, the author makes four kinds of projections about the future of CAI (see Chapter 5).

59. Suppes, P.; Jamison, D.; & Butler, C. Estimated costs of computer assisted instruction for compensatory education in urban areas. *Educational Technology*, 1970, *10* (4), 49-57.

Costs estimated as of 1970 (bears no relationship to today's rapidly shrinking costs).

60. Atkinson, R.C. *Ingredients for a theory of instruction. Technical*

Report Number 187. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1972.

Lists criteria for a theory of instruction necessary for deriving optimal strategies of teaching reading. These are 1) a model of the learning process, 2) specification of admissible instructional objectives, and 3) specification of instructional objectives, and 4) a measurement scale permitting cost assessment and reinforcements for the achievement of instructional goals.

61. Fletcher, J.D., & Suppes, P. Computer assisted instruction in reading: Grades 4-6. *Educational Technology*, 1972. *12* (8), 45-49.

Describes implementation of Computer Curriculum Corporation reading curriculum with the Honeywell 1648 Computer and Model 33 teletypewriters with standard ASC 11 keyboards.

62. Atkinson, R.C., & Fletcher, J.D. Teaching children to read with a computer. *Reading Teacher*, 1972, *25* (4), 319-327.

Describes the "strand" structure of the drill and practice program designed to supplement reading instruction in grades one to three, providing a flow chart for the Word Strand and sample exercises and giving cost estimates.

63. Fletcher, J.C., & Atkinson, R.C. Evaluation of the Stanford CAI program in initial reading. *Journal of Educational Psychology*, 1972, *63*, 597-602.

A detailed analysis of scores of forty-four matched pairs of subjects. Results indicated that 1) five-and-one-half months of CAI instruction yielded significant gains in reading among first grade students; 2) boys were helped more by CAI than were girls; and 3) most significant results were in sentence and paragraph comprehension, areas hardly touched by the CAI program.

64. Atkinson, R.C.; Fletcher, J.D.; Lindsay, E.J.; Campbell, J.D.; & Barr, A. Computer assisted instruction in initial reading: Individualized instruction based on optimization procedures. *Educational Technology*, 1973, *13* (8), 27-37.

Describes the expanded eight strand drill and practice curriculum and how monitoring student performance leads the computer to prescribe more practice for slower learning students and to all students for learning tasks which the computer "recognizes" as more difficult through its constant monitoring. Also described is a method for computing amount of computer time required for reaching a given score on a reading achievement test.

65. Atkinson, R.C. Teaching children to read with a computer. *American Psychologist*, 1974, *29*, 169-178.

Describes three levels of optimization of instruction: 1) Decision making within an instructional strand—which items to present, which formats to present them in, and when to schedule review; 2) decision making about allocation of instructional time to the various strands, or subareas within reading; and 3) decision making about distribution of terminal use time among students.

66. Campbell, J.O.; Lindsey, J.; & Atkinson, R.C. *Predicting reading*

achievement from measures available during computer assisted instruction. Technical Report Number 249. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1975.

When correlations were computed between rate of progress during CAI reading instruction and scores on standardized tests of initial reading skill, CAI measures were found to be better predictors than were reading readiness tests.

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76. Fletcher, J.D., & Suppes, P. *Computer assisted instruction in mathematics and language arts for the deaf*. Final report. Stanford, California: Institute for Mathematical Studies in the Social Sciences, Stanford University, 1973.
77. Chant, V.G., & Atkinson, R.C. Optimal allocation of instructional efforts to interrelated learning strands. *Journal of Mathematical Psychology*, 1973, *10* (1), 1-25.
78. Fletcher, J.D. *Transfer from alternative presentations of spelling patterns in initial reading. Technical Report Number 216*. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1974.
79. Atkinson, R.C. *Adaptive instructional systems: Some attempts to optimize the learning process. Technical Report Number 240*. Stanford, California: Institute for Mathematical Studies in the Social Sciences, 1975.

Illinois' Computer Based Education Laboratory

In 1960, research under the direction of Donald Bitzer, of the Coordinated Science Laboratory of the University of Illinois, developed a computerized teaching system named Programed Logic for Automatic Teaching Operation. The acronym, PLATO, has survived three major revisions and is (at the time of this writing) known as PLATO IV.

The first system was implemented with one high speed digital computer and one terminal. PLATO II was used from 1962 to 1974. PLATO III, making use of time-sharing, reached a peak of 71 terminals with twenty in use at one time. It was used from 1964 to mid-1973, and during its last two years PLATO IV was being installed. PLATO IV has remained in use from mid-1971 until the present.

During this time, many different languages have been employed. PLATO I made use of an ILLIAC I computer and PLATO II used the Control Data Corporation 1604 computer belonging to the Coordinated Science Laboratory. With both of these, machine language was used, but when the Computer Based Education Research Laboratory (CERL) was formed and PLATO III begun, several different programing languages were used before TUTOR III was created. TUTOR IV was implemented in 1971 and has remained the language of the present PLATO IV program which now makes use of a Control Data Corporation CYBER 73 computer system.

The student using PLATO IV must learn to use a computer terminal which has three vehicles for presenting information: 1) a plasma panel, 2) a microfiche slide projector, and 3) a random access disk record player. It can accept input from a keyset (similar to a typewriter keyboard) and from touching the screen, which is sensitive to interruption of 32 photoelectric circuits just in front of the leading surface of the panel. These divide the screen (16 x 16) into 256 half-inch squares. Breaking these circuits is a means of responding to the computer.

The visual display unit is the plasma panel which presents red lines on a screen much like the character and digit lines on a common hand or tabletop calculator. The PLATO IV plasma panel (screen) is contrived of two layers of glass, 8½ inches square. Between these is a thin layer of trapped gases (neon and others). Each pane of glass has 512 thin wires running through it. The two panes are rotated so that their wires are perpendicular. By firing combinations of these 1024 circuits, 262,144 points can be lighted. Lighting of these points is sufficiently fast to allow the computer to write its maximum of 2,048 characters at the rate of 180 per second. Unlike the cathode ray tube, the plasma

panel "has a memory." It continues to display indefinitely, or until a change is directed by the computer or the student using the terminal.

The panel is also used as a rear screen for the projection of slides printed on microfiche cards. This requires the connection of a peripheral device (accessory) called the "random access image selector." This slide projector can be computer directed to show any of the slides on a microfiche which is four inches by seven inches. Access time is one-fifth of a second. Each microfiche has space for 256 images. When both rear screen projected images and plasma panel characters are to be shown, the portion of the panel directly behind the lighted plasma characters usually will be blacked out. The terminal must have a source of compressed air in order to use the projection device, since air pressure is used to move the microfiche from one display point to another.

When directions were given to touch plasma characters, pictures, and diagrams, programs were successful. However, the accuracy of the screen placement of rear screen projected microfiche was not sufficiently accurate for using the touch panel as a response device. There are some problems with the touch response system in other situations, since the toucher may break several circuits in carrying out the touching of a particular point on the screen, or since the toucher with small fingers may not break any circuit.

The audio presentations to the terminal user are made through stenographic headphones. The audio presentations are stored on fifteen-inch mylar magnetic disks, each of which contains about 23 minutes of sound broken up into as many as 4,000 messages. No one message may be less than one-third second or more than 45 seconds long. The time required for locating and starting an audio presentation is one-half second or less. As of 1977, little use of the audio peripheral device, known as the "random access device" had been made by any group other than personnel developing the reading curriculum, persons who would have been hard put to teach reading without it. (The average reading lesson is nearly three minutes long. Almost a minute of this time is audio presentation—with simultaneous video, of course.) One reason is that the device runs on compressed air.

To be taught by the PLATO IV system, the student finds an operating (on) terminal and presses the NEXT key (one of 63 on the keyset). On the plasma screen then appears "Welcome to PLATO." The student responds by typing (in capital letters, since there are no small letters) the name by which the computer recognizes him and again presses NEXT. As directed by the computer display, the student then types the name of his course and presses STOP while holding down the SHIFT key. Then he

types his password and presses NEXT again. From then on, the student interacts with the computer until finished, at which time he again presses the STOP key while holding down the SHIFT key.

Although PLATO was initiated in 1960, the PLATO Early Reading Curriculum (PERC) was not begun until funded by NSF contract C-723 in June 1971. The aims formulated at that time were 1) to create a complete K-6 computer based curriculum in reading; 2) to build in the possible use of a variety of instructional modes, thus permitting teachers to maintain their own styles of teaching reading; 3) to take full advantage of the advanced devices available to the user of a PLATO IV terminal; and 4) to demonstrate the feasibility of the resulting curriculum in a variety of school settings.

The first lessons were tested in 1972, even before the random access audio device was available. During a six week summer pilot session it was found that young disadvantaged children not only could pay attention throughout their ten- to twenty-minute sessions, but also could (and did) ask for repeats at the end of their sessions. (It was also found that poorly constructed lessons bored children when presented by computer, just as they do when presented by human teachers.)

In 1972, the PERC group, led by Priscilla Obertino, Materials Coordinator, and Robert F. Yeager, senior author and programer, found that children related to the terminal in four ways: 1) active aggression, exploring how the machine will respond to hitting, shaking, and probing; 2) conventional (expected) responding; 3) passive, responding only when told to do so by the terminal or by a human teacher; and 4) inactive, exploring the terminal not at all. Observing student behavior was the major means of evaluating early lessons and improving responses from all four types of students.

The early lessons were designed to teach students to use the touch panel, to type stories with the keyset, to remember items presented and then removed from the screen, to match letters, to match words, to choose objects with names which are spelled with a T, to choose letters representing the certain speech sounds, to match words with pictures, to type words pictured, and to touch direction words such as UP and DOWN. In addition, a number of well known children's books were presented in such a way that touching any word in the story caused it to be pronounced by the audio device.

Between 1973 and 1977, the development of the reading program continued and the number of lessons was increased to 200. These lessons, comprising more than 1,500 exercises, were grouped into the following categories to meet approximately 400 objectives.

1. *Orientation*—Freddy Frog helps students learn to use the touch panel and keyset.
2. *Date activities*—learning days of the week, months, and how to read a calendar.
3. *Letter discrimination*—covering parts of a letter until a match can be chosen.
4. *Word detail*—matching words which at first are chosen from dissimilar distractors and later are chosen from similar appearing distractors.
5. *Memory skills*—choosing "new" pictures (not in a previous display), or, instead, the "old" ones.
6. *Letter names*—hearing, seeing, and choosing words beginning with a particular letter.
7. *Alphabet*—completing a sequence by choosing letters.
8. *Letter sounds*—sorting groups of words by sounds and responding to alliterative stories.
9. *Blending*—typing three-letter cvc trigrams starting with the consonant given.
10. *High frequency sight words*—a look-and-say presentation in isolation and in context followed by typing the word and choosing it from a set of distractors.
11. *Enrichment sight words*—picturable words taught as high frequency words, plus being pictured.
12. *Word meanings*—by touching appropriate printed words the child makes the display respond.
13. *Sentence building*—by touching words on the screen in order, the student creates sentences which are then displayed. If grammatical, the sentence is illustrated by the computer.
14. *Stories*—picture stories are displayed so that touching a square next to a line causes that line to be read aloud by the computer.
15. *Timed reading*—students are given the time required for reading a story and are asked multiple-choice questions about it.
16. *Stories written by students*—students type their own stories for storage by the computer and reading by other students and the teacher.
17. *Games*—memory, discrimination, and location activities with computer reinforcement.

These activities are prescribed for each student by his own human teacher, who spends about an hour each week typing prescriptions for the class. Using an index of currently available activities, the teacher

1. *Orientation*—Freddy Frog helps students learn to use th
panel and keyset.
2. *Date activities*—learning days of the week, months, and
read a calendar.
3. *Letter discrimination*—covering parts of a letter until a
can be chosen.
4. *Word detail*—matching words which at first are chose
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15. *Timed reading*—students are given the time requ
reading a story and are asked multiple-choice q

the terminal displays the word and its definition.

84. PLATO (booklet). Urbana, Illinois: Computer Based Education Research Laboratory, University of Illinois, 1974.
Describes PLATO system, features, and uses. Gives a time-line history of the project.

85. Obertino, P. The PLATO reading project: An overview. *Educational Technology*, 1974, *14* (2), 8-13.
Presents the aims of the PLATO Elementary Reading Curriculum (PERC) group and details their early program tryouts and findings about children's interaction with computer terminals.

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Contains the previous article and 19 pages of program samples.

87. Meller, D.V. *Using PLATO IV*. Urbana, Illinois: Computer Based Education Research Laboratory, University of Illinois, 1974 (rev.).
A well-written guide to the potential user of the PLATO IV system. Contains a description of the terminal and peripheral devices available; a description of the system; directions for getting on-line; directions to authors, instructors, and students; and maintenance procedures.

88. Lyman, E.R. *PLATO Highlights*. Urbana, Illinois: Computer Based Education Research Laboratory, University of Illinois, 1975 (rev.).
Contains a timeline of important events in the history of the PLATO systems and lists 262 publications dealing with PLATO through 1975.

89. Lyman, E.R. *PLATO Curricular Materials*. Urbana, Illinois: Computer Based Education Research Laboratory, University of Illinois, 1976.
A catalog of CAI programs available to the operator of a PLATO IV terminal. Each listing followed by the name of a contact person and his/her phone number.

90. Francis, L. *PLATO IV Terminal Peripheral Devices*. Urbana, Illinois: Computer Based Education Laboratory, University of Illinois, 1976.
A frank assessment of the usefulness, potential, and the weaknesses of the various peripheral devices which can be attached to the PLATO IV terminal. Especially valuable is the section by Yeager. "Using Audio with CAI Lessons: Experiences of the PLATO Elementary Reading Project" (43-54).

91. Obertino, P., et al. *Elementary reading on PLATO IV*. Urbana, Illinois: Computer Based Education Research Laboratory, University of Illinois, 1977.
The most recent description of the PLATO IV reading program. Provides an introduction of the project (PERC), a description of the PLATO IV hardware, a survey of the 17 kinds of activities, and a listing of teacher management options.

92. Michael, G., & Sliger, M. *LARS instructor's manual*. Urbana, Illinois: Computer Based Education Laboratory, University of Illinois, 1976.
LARS (Language Arts Routing System) is a set of modules designed to teach elementary verbal skills that require following a set of rules. Students are routed to 54 topics in four areas of beginning College

English by their performance on diagnostic tests.

93. Breland, H.M. *Planning for the evaluation of the PLATO Computer Based Instructional System: Attitudinal and Performance Evaluation in Elementary Schools.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1974.
    Presents plans for testing, observing, and assessing attitudes of students in PLATO reading and mathematics programs.
94. Visual search activity: *A tool for the evaluation and development of computer assisted reading instructional programs. Annual Report.* St. Louis: Behavior Research Laboratory, Washington University, 1976.
    Results suggest that PLATO displayed print is read less efficiently than book print.

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102. Smith, S.G., & Sherwood, B.A. Educational uses of the PLATO computer system. *Science*, 1976, *192*, 344-352.
103. Steinberg, E.R. *The evolutionary development of CAI courseware.* Paper presented at the annual meeting of the American Educational Research Association, Washington, D.C., April 1965.

Wisconsin Research and Development Center for Cognitive Learning

There are two types of computer applications to reading under development at the University of Wisconsin's Research and Development Center; The Wisconsin System for Instructional Management (WIS-SIM) and an on-line program for diagnosing reading difficulties with a PLATO IV terminal. The more extensive development has been of the former, since it designed to capitalize on the well-developed set of goals and objectives of the Wisconsin Design for Reading Skill Development (WDRSD) and has been under development for a longer period of time.

WIS-SIM was originally financed by NIE and a Title III ESEA grant to the McFarland Community Schools. The purpose of the R and D Center in developing WIS-SIM was to further the cause of individualized education by identifying school system, school building, classroom, and individual pupil needs through more efficient ingestion, storage, and retrieval of student and program information. The areas chosen for developing computer managed instructional schemes include elementary reading, mathematics, and science.

In order to implement WIS-SIM in reading, one must implement the management system it is designed to support (WDRSD). The first step, then, is to test all individual students with the criterion referenced placement tests of the three strands (Word Attack, Comprehension, Study Skills) of the WDRSD. Once the tests had been administered (usually at the beginning of a school year), a data base for reporting is stored in the computer's memory. Of course, the second step is arranging computer services. Having a local computer available is best. Next best is having a terminal available for on-line communication with a distant computer, and the least satisfactory is a "batch" system requiring tests to be mailed or carried to the computer.

Since the objectives and goals of the WDRSD are hierarchically ordered, the computer can generate both a list of tasks mastered and a list of possible next assignments. Since pupil data carry the designation of school attended, classroom to which assigned, and school district or system, printout profiles can be requested to show school or class performance on tests of particular units (areas). Also available are suggested topics for instructional groups and suggested members of those groups (those who *have not* mastered the topic, but who *have* mastered the prerequisite topics or tasks), as well as recommended topics for assignment or teaching to individuals who were omitted from the suggested groups.

Pilot testing of WIS-SIM took place in 1975-1976 in seven schools from four Wisconsin school districts and one district in Minnesota with six elementary schools. Pilot tests help the designers improve the system by making minimal demands on teachers attempting to learn and implement the system in their classrooms.

The diagnostic program developed at the University of Wisconsin uses a PLATO IV terminal with telephone line connections to the computers of the Computer Based Education Research Laboratory of the University of Illinois. The initial step in conducting such a diagnosis involved comparing results of a group administration of the Stanford Diagnostic Reading Test, Level II, Form W, with results of a computer administered version of the same test. At first, results were not comparable. By changing the required response (touching a word in a box next to the answer selected from a multiple-choice display) so that when the word was touched once a box appeared around it and with a second touch being required before the computer registered the response, comparability was achieved. Further work devising on-line diagnostic tests for letter-sound generalizations was in progress at the time of this writing.

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104. Belt, S.L., & West, S.F. *Implementing individually guided education now with the aid of a computer.* Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin (mimeo, n.d.).

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105. Belt, S.L., & Skubal, J.M. *Individually guided education and the Wisconsin system for instructional management* (WIS-SIM). Paper presented at the annual meeting of the Association for Educational Data Systems, New York, May 1974.

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107. Belt, S.L. *Some CMI design considerations to meet the requirements of individually guided education.* Paper presented at the annual meeting of the American Educational Research Association.

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self-contained classroom, listing sources of computer service to schools.

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109. *Wisconsin system for instructional management: Overview.* Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1975.
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110. *Wisconsin system for instructional management: Instructor's manual.* Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1976.
A manual for use in conducting inservice training for teachers about to try using WIS-SIM.

111. *Wisconsin system for instructional management: Teacher's guide.* Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1976.
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112. Belt, S.L. CMI *design considerations which enhance transportability to IGE schools.* Paper presented at the annual conference of the Association for Individually Guided Education, Denver, November 1975.
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Florida State University's Computer Applications Laboratory

The Computer Assisted Instruction Center at Florida State University has conducted several investigations and has completed several projects involving the teaching of reading. The original central processing computer at FSU was an IBM 1440 programed for time-sharing between several keyset 1050 terminals, some of which were equipped to control slide projectors and/or tape recorders. The programing language was COURSEWRITER.

The first reading program developed at FSU for presentation by computer was entitled "Reading for Illiterate Youths and Adults." This program was intended to promote functional literacy for adults reading fifth reader level and below. Twenty-four lessons of the second reader level program were created, slides were made, and the lessons entered into the computer. Third reader lessons with slides were ready for computerization and lessons were written for the fourth, fifth, and sixth reader levels. The lessons were written so that audiotapes were optional. Although the software was developed, the computerizing of this program could not be completed because the funding (federal) was discontinued at the end of the first year.

A second project of the Florida State CAI Center was the implementation of the DOVACK model in cooperation with an ESEA Title III project at the nearby Monticello, Florida, Elementary School. The DOVACK (Differentiated, Oral, Visual, Aural, Computerized, Kinesthetic) model is a version of the language experience approach. Each day each student dictated a story to a teacher or aide who recorded it and then redictated it and typed it on the terminal of the CDC 6400 computer serving the project. Overnight the computer printed out

each new story. The next day each student reread computer printouts of stories dictated earlier. Every sixth school day the computer created a test which was a random sample of words dictated by the student since the last examination. Since videotape and field trips were also used in the DOVACK model, the role of the computer was primarily that of printer, record keeper, and test producer. Records available to the teachers included the list of words dictated by each student, his or her test performance, the total number of words dictated, and his or her rate of word acquisition. The cost per student was given as $770, above the school board's usual price per pupil of $658 per year.

A third project involved teaching sight vocabulary to EMR students using an IBM 1500 instructional system and an IBM 1800 central processing computer. Thirty tutorial lessons, each presenting nine words to be associated with pictures illustrating them, were developed in the COURSEWRITER II language and field tested with the IBM 1510 terminal (CRT with light pen) in Wakulla County, Florida. This was partially funded by an ESEA Title VI grant. At the end of the first year, the project switched from computer assisted instruction to computer managed instruction which required only periodic testing by the computer. During the third year, the project made no use of computers.

A fourth project, conducted in cooperation with the English department, involves the use of the CDC computer which the Florida State Center for Educational Development and Evaluation now uses as the central processor for its CMI and CAI projects. The purpose of this project is to test students for their competency and give them prescriptive feedback about skills in which they need improvement. Students needing to be tested (for basic English competency or for earning grades in one or more of their courses) come to the Assessment Resource Center. The student fills in a machine scorable form indicating his identity and the unit of instruction on which he wishes to be examined. A proctor examines the student's ID card and verifies his identity before going to the terminal and asking the central computer to process the request and determine the appropriateness of the requested test for this student. If all is satisfactory, the computer tells the proctor which test to give the student. The student completes the machine scorable test and hands it in to the proctor. The proctor inserts it in a document reader which relays student responses to the computer. The computer then prints out a prescriptive report to the student, while holding the complete record of this student's per-

formance available for the instructor whenever the instructor requests it. The advantages of this program are that the use of machine scorable tests limits the amount of on-line computer time (and money) required and that instant feedback is provided to students.

At Florida State University several other units of instruction were developed. Among these was a tutorial reading program (in COURSEWRITER I) for preschoolers. In this program words were to be matched to words, pictures matched to pictures, and words matched to pictures. This required the computer to control a tape recorder and a slide projector. Another was a tutorial program (in COURSEWRITER II) for slow learning second graders. This required a cathode ray tube terminal and light pen. Students were presented stories followed by analytic questions, vocabulary exercises, and thought problems. Unfortunately, neither of these programs is now available.

However, new programs may be available soon. "Teaching pre-reading skills to hearing impaired children" is a program developed at Florida State University by a team headed by Nelson Towle, director of the computer assisted instruction program. In 1977-1978, a program to analyze reading difficulties (author—F.J. King) and a program designed to teach teachers to use appropriate reading methods in teaching content area reading (author—J. Lundstrum) were being developed. All of these programs were being written for display and response with PLATO terminals.

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123. Wills, M. DOVACK's machines help children read. *American Education,* 1971, *7* (5), 3-8.
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A 24-page report of the DOVACK program originally presented to the White House Conference on Children, December 1970.

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Thirty lessons of nine words each employed computer presented pictures to be matched with words by shining a light pen on the screen of the CRT equipped terminal. It was concluded that pictures could help.

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Penn State's Computer Assisted Instruction Laboratory

At the Pennsylvania State University, the application of computers to reading instruction took the form of inservice education. A huge project—funded by the Bureau of the Handicapped, the Bureau of Educational Personnel Development (USOE), and the Penn State Foundation—was mounted to bring fundamentals of remediation to teachers of children who would become educationally retarded by age nine or ten. This project, named CARE I (Computer Assisted Remedial Education), was intended to be the prototype for several similar projects.

The central computer, an IBM 1130, was connected by telephone lines to terminals housed in trailer trucks so that they could be taken to remote sites around the state. Each terminal consisted of a cathode ray tube with light pencil, a keyboard, an audio device, and a self-contained image projector and screen. Students read a handbook prior to working at the drill and practice exercises presented at their terminal. The instructional language used to create the exercise was COURSEWRITER II.

A similar program was created to teach the principles of phonics instruction and i.t.a. to teachers and prospective teachers. Again, a handbook was created and the CAI was supplemental drill and practice for the course. In an evaluation study, students were branched to CAI according to the pretest performance. The computer presented illustrative lessons, a student self-evaluation, and multiple-choice practice exercises. It was concluded that the CAI course was valid for preservice education of teachers.

In addition to the teacher education courses offered through computer assisted instruction, the Computer Assisted Instruction

Laboratory at Penn State also created a literacy program called LITE (funded by USOE). This program used the computer to improve students' literacy levels (up to eighth reader level) by providing job oriented reading materials and constant feedback on their improvement in reading. A summative evaluation found students made some gains in reading and great gains in their knowledge of occupations. Furthermore, student attitude was found to be positive. The program (now available) appears to be useful for junior high, high school, and vocational students.

The Computer Assisted Instruction Laboratory has also created a program for teaching fourth and fifth grade students to read word problems in mathematics. However, after a field test, the CAI group scores did not exceed those of the controls.

The CAI Laboratory closed June 30, 1977.

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134. Cartwright, G.P., & Cartwright, C.A. *Handbook for CARE 1—Introduction to the education of exceptional children.* Laboratory Report Number R36. State College, Pennsylvania: Computer Assisted Instruction Laboratory, Pennsylvania State University, 1970.
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135. Hall, K.A. Computer assisted instruction: Problems and performance. *Phi Delta Kappan,* 1971, *52* (10), 628-631.
    Points out problems and successes in CAI implementation.

136. Cartwright, G.P., & Cartwright, C.A. *Computer assisted remedial education: Diagnostic teaching of preschool children.* Handbook for CARE 2. Report Number R54. State College, Pennsylvania: Computer Assisted Instruction Laboratory, Pennsylvania State University, 1973.
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143. Hall, K.A. *CARE: Computer assisted remedial education.* Paper presented at the SECOS Conference, New Paltz, New York, May 1974.
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Brigham Young's Institute for Computer Uses in Education

In the early 1970s, Brigham Young University's Institute for Computer Uses in Education began to develop the courseware for TICCIT (Time-Shared Interactive Computer Controlled Information Television) to be developed by the Mitre Corporation. The purpose was to take advantage of the informational and motivational strengths of color television by controlling its presentation with the computer and adding such CAI as might enhance the presentation. One major task accomplished was the development of a technology which could produce still frames on the TV screen for careful viewing and analysis.

The TICCIT terminal is supported by the TICCIT system which provides random access/retrieval of video cassette decks, the playing of which can be stopped, rewound, run fast forward (in specific time intervals), run forward (at the usual rate), run frame-by-frame, or held at pause. They can be played as part of an instructional sequence or as pure entertainment.

Eventually a special TICCT computer keyboard was developed with several special keys. Some of these are listed and explained below.

RULE KEY: Gives an example or a particular case of the generalization or rule to be learned.

EXAMPLE KEY: Gives an example or a particular case of the generalization or rule to be learned.

EASY KEY: Gives an easier version of the rule or example.

HARD KEY: Gives a harder version of the rule or example.

HELP KEY: Gives the most simple or basic information about what the student is to learn.

PRACTICE KEY: Presents problems related to the rule or concept to be learned and provides feedback after the student's response.

MAP KEY: Displays list of options available to the student, suggests prerequisites, and orients student to state of his current progress.

OBJECTIVE KEY: Explains what is to be learned in the forthcoming lesson.

ADVISOR KEY: Advises student of his current progress and the merits of the particular path he has followed in attempting to master the objective.

By pressing any of these keys, the student caused the computer to present (on the screen) still color frames which performed the keyed functions. Each slide was labeled on the bottom for better orienting

the student as to its purpose. The labels gave both the component upon which the student was working and the number of the frame (called page) of that component (i.e., PAGE 3 of 5, EASY, MAP, etc.).

The availability of these keys was accompanied by the requirement that program authors had to define the rules and concepts to be learned and then offer examples of varying degrees of difficulty and practice items to clarify and lead students to mastery of those concepts and rules.

Other visuals (drawings, cartoons, artwork) are entered into the computer's memory by a graphic digitizer which scans the visuals through three color filters (red, green, blue) three different times to allow storage of seven colors (red, green, yellow, blue, blue-green, white, and black) for transmission by the computer controlled TV screen. Audio for the system consists of the audio accompanying the videotape decks.

Computer record keeping allows teachers to determine which lessons students have completed and which ones they are working on. Progress within lessons and scores on lesson posttests are also available to teachers when requested of the TICCIT computer system. Log tapes of student on-line time provide item analyses of practice and test items. A "mailbox" feature allows a TICCIT user to send messages to any (or all) other TICCIT user(s). Receivers receive the messages only when they elect to "read their mail" at their own terminals.

The TICCIT Reading Program was developed at Brigham Young University at the same time as the General Education Critical Reading Program (GECRP—required of all freshmen). Both courses were begun in Winter 1975, and in Winter 1976 the latter course was taught to ten sections of students. Many of the students used the TICCIT Reading Program as a supplement to the once-a-week class discussions of GECRP. Those students using the TICCIT program who were helped most were those who started with the lowest scores. A one teacher pilot study indicated a 10 percent advantage on evaluation test scores for students using TICCIT and generally favorable student response to the computer program.

Financial problems and the small number (28) of available terminals led Brigham Young to discontinue the TICCIT Reading Program in 1976-1977. However, a new and reduced student fee for CAI time ($1 per hour) and a maturing General Education Program at Brigham Young have led to renewed use of the TICCIT Reading

Program, Fall 1977, with approximately 40 students. Information for further use of the TICCIT Reading Program had not been received at the time of this writing.

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Includes description of procedures designed to enhance learning with the TICCIT system. Describes original funding by NSF Office of Computer Innovations beginning in 1971-1972.

153. Fletcher, J.D. *Computer applications in education and training: Status and trends.* Report number NPRDC-TR-75-32. San Diego: Navy Personnel Research and Development Center, 1975. (ED 108 681)
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154. Herlin, W.R.; Bance, G.; & Hansen, D.M. *Teaching college level reading in a computer assisted computer managed setting.* Paper presented at the annual conference of the International Reading Association, Anaheim, May 1976.
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155. Hansen, D.M. Personal correspondence, October 13, 1977.
Describes development of TICCIT Reading Program and the successes and failures to date in implementing it.

156. Merrill, M.D. *Premises, propositions, and research underlying the design of a learner controlled computer assisted instruction: A summary for the TICCIT system.* Working paper 44. Provo, Utah: Brigham Young University, Division of Instructional Services, June 1973.
Points out four aspects of TICCIT that make it a unique CAI vehicle.
1. It has a built-in learning strategy. The lesson author supplies the content but must follow the TICCIT presentation strategy.
2. The learner selects both his content and his strategy for learning that content.
3. The objective of the TICCIT system is to make the learner independent of the system—able to proceed without it.
4. Authors (teachers and instructors) prepare lessons in natural language. There are constraints on the displays they may use,

but the constraints are very similar to those facing the teacher in non-CAI settings.

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Describes TICCIT system operative at the Model Secondary School for the Deaf and briefly sketches research and development to be attempted in the future.

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Delaware's PLATO Project

The University of Delaware PLATO Project began in 1975-1976 with the purchase of CDC PLATO from the Control Data Corporation and a contract with the University of Illinois for access to the Illinois (CERL) PLATO system. By 1977, thirty-two PLATO terminals were installed on campus and by 1978, forty-eight were installed. All of them were equipped with touch panels (see section on University of Illinois); six terminals also had random access audio devices. With these six, John Pikulski and Peter Pelosi of the Reading Study Center began the development of CAI reading activities in four ways.

First, graduate students and faculty of the Reading Study Center familiarized themselves with PLATO reading lessons developed at the University of Illinois. Then the group began developing their

own lessons, both for instruction of children and for teacher education in reading. In 1976-1977, approximately forty children (clients of the Reading Study Center) used PLATO for an average of six hours each. In 1977-1978, fewer children were expected to spend more time at the terminals.

One of the programs is "Read Along with PLATO," developed by Peter Pelosi and Jessica Weissman (chief programer for the Reading Study Center programs). The lesson starts by presenting the student with a list of twenty short stories from which to pick one to read. After the story is picked the terminal displays a page line by line and asks the student to read along as it reads to him. The child is guided to the proper line by an arrow that moves down the left side of the text.

There are three types of reading available. On the first reading of each page, the student listens while PLATO reads. On the second reading, the student reads along with PLATO. In both of these readings, the machine stops at the end of each line. The student touches one box (shown on the display panel) to start the oral reading of the next line, or another box to read again the line just completed. The third reading is computer assisted only if the student has difficulty. When he does, he can touch a box requesting that the computer read the line for him. If so desired, the teacher can direct the computer to offer only one (any one) of these three types of reading.

A second program is SWAT (Sight Word Attack Team), developed by Rosalie Bianco, Peter Pelosi, Jessica Weissman, and Bonnie Seiler. SWAT now includes a set of sight word teaching lessons, a test, and a test results program (giving results to the instructor). All lessons use a theme involving spies and passwords.

The sight words are first presented in groups of four so that the pupil can select one he wishes to learn. Then an amusing story, illustrated by animations, is printed on the screen. Pupils can read it for themselves or direct the computer to read it aloud to them. (In this program all instructions, explanations, and remedial messages are printed on the screen, but the student can call for any of them to be read aloud.) In this story, the target word appears once on each line.

Next, a "secret message" appears on the screen. The pupil chooses the target word from four foils, thus completing the message. After that, the pupil is presented a picture of a "DeKoder machine." By touching letters displayed on the machine, the pupil fills blanks in sentences with the target word. The final two activities in this lesson require the pupil to 1) choose the target word from a scrambled set

of words and 2) identify the presence or absence of the password (a correctly spelled target word) in a sentence by touching a box labeled "yes" or a box labeled "no." The time required for this sequence is approximately ten minutes per word.

The SWAT promotion test was developed by Rosalie Bianco, Peter Pelosi, and Jessica Weissman. Three versions are available for the pupil to choose from. In the first, "letter linker," children hear a word pronounced and indicate their recognition by touching it on the display panel, where it has been displayed among several nonsense word foils. In the second version, "sentence sayer," the computer displays a sentence with a blank in it, along with the target word and several foils, which are other sight words from the program. The pupil is to touch the word which best fills the blank. The third version, "supreme decoder," is the same as the second, except the sentence is read aloud by the computer as it is displayed. A beep is substituted for the blank. Results are reported instantly to the student as a promotion or as failure to get the promotion (to the rank of letter linker, sentence sayer, or supreme decoder).

SWAT Promotion Test Results, developed by Rosalie Bianco, Peter Pelosi, and Jessica Weissman, is a program that gives the teacher a report (right at the terminal) of the pupil's correct responses to the test items and the time elapsed before each correct response.

The "Word Zoo," developed by T. Stevenson Hansell and Jessica Weissman, is a game format lesson in which students group words into boxes (called "cages") containing one class of words. To put a word *animal* in its *cage* the pupil first touches the word and then the box (cage) in which he wants it to appear. The word changes locations on the screen. One game calls for words to be classed into one of four groups—words with prefixes, words with suffixes, words with both prefixes and suffixes, and words with neither prefixes nor suffixes. Another game calls for classifying words according to the meaning of the prefix *re*, with which each word starts. When the student needs help, the computer will present a sentence containing the word which the pupil is unable to classify.

When the pupil decides that he has completed the caging of the word *zoo*, PLATO marks his misplaced words. If he makes new errors, the computer helps him until all the words are properly caged (classified).

Two programs have been developed for helping teachers and prospective teachers develop skills helpful in teaching reading. FASTER (Fast Accurate Symbol Transcription for Evaluating Reading),

developed by John Pikulski and Deborah Braendle, includes four games. These teach the student to score and interpret a word recognition test, use error marks required for scoring an informal reading inventory (IRI), and interpet scored IRI passages and word tests.

The "Sight Word Method Trainer," developed by Peter Pelosi, Jessica Weissman, and Bonnie Seiler, requires the student to watch cartoon sequences displayed by the computer. Each sequence shows a teacher teaching a sight word with a particular method. The student is told to stop the cartoon when the teacher makes an error and tell what type of error has been made. If the student misses the error, PLATO stops the sequence and asks the student to identify the error which has been made.

Annotated References

166. Hofstetter, F.T. *Second summative report of the Delaware PLATO project.* Newark, Delaware: University of Delaware PLATO Project, 1977.
Gives the history and development of the Delaware PLATO project, applications in 19 areas, and evaluation efforts. A section entitled "Education" describes the uses of PLATO made by College of Education personnel. Several reproductions of PLATO visual displays are included in the report.

167. Seiler, B., & Weissman, J. *Remedial reading on a computer called PLATO.* Paper presented at the annual convention of the Diamond State Reading Association, Dover, Delaware, November 1977.
Describes three units of instruction developed and tried.

Additional Reference

168. Seiler, B.A. Personal letter, October 18, 1977.

Pittsburgh's Learning Research and Development Center

Originally funded in 1965, the Learning Research and Development Center installed computers in its demonstration school (McAnulty School, Pittsburgh) in 1968. At that time the school was demonstrating Individually Prescribed Instruction (IPI), and the use of computers was envisioned as a way of further individualizing instruction by providing computer management of reading and computer assistance in mathematics and spelling.

Eventually the demonstration school was discontinued. However, the computers were directed toward the solving of other problems such as classification, and a CAI spelling program was developed. At the

time of this writing a vocabulary program for college reading improvement was being developed.

Annotated References

169. Ragsdale, R.G. The Learning Research and Development Center's Computer Assisted Laboratory. *Digital Equipment Company User's Society Proceedings*, 1966, *5*, 65-68.
    Includes a description of Westinghouse designed CROWN (random access audio devices), usually thought necessary to CAI at lowest levels of reading, spelling, and mathematics.

170. Peake, Charles H.; Glaser, Robert; & Cooley, William W. *Program plan and budget request.* Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1968.
    Gives plans for CAI instruction in mathematics and spelling. Spelling includes these factors:
    1. Study history file
        a) daily
        b) permanent (updated daily)
    2. Answer processing (of all incorrect responses)
    3. Variable word list
        The present list is fixed and all students proceed through it in linear fashion. However, plans underway for lists varied according to individual student error patterns.
    4. Branching—a function of *both* immediate response *and* error-pattern data. The student's history file (see 1 above) will be interrogated to determine if immediate error is part of a long term pattern.

171. Beck, Isabel L., & Bolvin, John C. A model for nongradedness, the reading program for individually prescribed instruction. *Elementary English*, 1969, *46*, 130-135.
    Predicted that a CMI reading program is to be in effect in the fall of 1968. It was to include: 1) Reports on which students were working on which objectives, and 2) daily progress summaries on each student.

172. Holland, J.G., & Doran, J. Teaching classification by computer. *Educational Technology*, 1972, *13* (12), 58-60.
    Describes a 160-item classification CAI program using touch sensitive screen showing rear screen projected images. This served as the basis for the CAI spelling program.

173. Block, Karen K.; Tucker, S.A.; & Butler, P.A. *Spelling, learning, and retention under variation in focal unit of word presentations in a computer assisted spelling drill.* Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1974.
    Research leading to the improvement of the CAI spelling program is described. The authors conclude that focal unit and manner of presentation did not affect retention of spellings and that audio presentations had no effect. Focal unit did seem to affect initial learning.

Additional References

174. Cooleyk, W.W., & Glaser, R. *An information and management system for individually prescribed instruction.* Working Paper Number 44. Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1968.
175. Bolvin, J.O. *Individually prescribed reading instruction—rec[illegible]g program.* Paper presented at the College Reading Association Confer[illegible]e, Knoxville, April 1968.
176. Judd, W.A. The development of an on-line laboratory for CAI and other behavioral research, 1964-1968. Technical report series. Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1969.
177. Block, K.K., & Simon, D. *Computer assisted spelling.* Progress Report. Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1972.
178. Bell, F.H. *Computer related laboratories: An interdisciplinary approach to learning.* Paper presented at the summer conference of the Association for the Development of Computer Based Instructional Systems, Portland, Maine, August 1976.
179. Holland, J.G., & Soloman, C. *Komputer Konkocted Kurrickulum: A review of CAI spelling.* Pittsburgh: University of Pittsburgh Learning Research and Development Center, 1975.

New Hampshire's CARIS System

Partially funded by a grant from the University of New Hampshire Central University Research Fund, the CARIS (Computer Animated Reading Instruction System) program was designed to teach beginning reading to handicapped children using a low cost (under $15,000) computer animation system. The first phase of the prototypic system, which has been developed and pilot tested by Leo Geoffrion and Daniel Bergeron, presents a display of several printed nouns on a light-sensitive CRT. The child learns to select one of the words by touching a light pen to that word.

When a word is touched, the noun list disappears from the screen, where it is replaced by a picture of the word selected. A list of verbs is shown on the left side of the screen at this time. By touching the verb (printed) the child causes the noun pictures to act out the intended meaning of the verb. (For example, DOG RUNS.) Following this action on the screen is the representation of the noun list. As the child becomes adept at recognizing the nouns and verbs, new ones replace old ones on the list.

The computer used for this program was a PDP 11/40 (an inexpensive computer utilizing floppy disk memory storage) with a DEC VT 11 graphics display (a newer version using a less expensive DEC LSI 11 is

being developed in 1977-1978). No audio device was required. To tailor the system to the child, the program prescriber can vary 1) the number of words initially presented, 2) which words are included, 3) the rate at which new words are added, 4) the number of words displayed at once, and 5) the frequency of reordering of words in any list.

In the second phase, children select words to create a sentence. When all the necessary words have been selected in the proper order, the computer animation shows the meaning of the sentence.

A third phase is under development. In this phase of the program, the child will select a word, again using a light pen. The computer then will request that the child choose letters to spell the word. As development continues, more pilot testing and updated reports should be forthcoming.

The CARIS System is intended to fit into a larger program planned for aiding language development in deaf and language handicapped children. Projected activities will involve the learner in picture drawing, animation, and computer based games designed for teaching initial language and reading skills.

Annotated References

180. Bergeron, R.D., & Geoffrion, L.D. Computer animation as a tool for teaching reading to the physically handicaped, in M.R. Cannon (Ed.), *Proceedings of the Fifth New York Bioengineering Conference*. New York: Pergammon Press, 1977.

Describes the development of the CARIS program, its basic commands, and its eventual goals.

181. Geoffrion, L.D., & Bergeron, R.D. *Initial reading through computer animation*. Paper presented at the annual meeting of the American Educational Research Association, New York, April 1977.

Describes the CARIS system and its initial evaluation with four types of handicapped children. It includes two case studies and suggestions for improving the program.

Additional Reference

182. Geoffrion, Leo. Personal letter, October 18, 1977.

Purdue's Teacher Education Effort

At the time of this writing, educators at Purdue University were using a PDP 11/70 Microcomputer to create demonstration lessons in secondary reading. The author language being used was a revised version of PILOT. The lessons were stored on floppy disks (memory records) and on cassette tapes. The CAI consisted of tutorial and simulation lessons designed to cover about two-thirds of the content of the secondary courses to which they relate. The remainder of the context is expected to be presented in standard lecture-discussion classes.

Annotated Reference

183. Kamil, M. Personal Telephone Message. December 1977. Desoribed equipment and author language used in developing Purdue's CAI secondary reading program for inservice education teachers.

Additional References

184. Elliott, T.M. *Computer based education at Purdue University.* Lafayette, Indiana: Computer Based Education Subcommitttee, Computing Center Advisory Committee, Purdue University, 1974.

185. Feldhusen, J.F. *CAI programs developed at Purdue University by faculty and graduate students.* Lafayette, Indiana: Educational Psychology Section, Purdue University, 1968 (mimeo).

Computer Applications in other Colleges and Universities

Colleges and universities have applied computer technology to reading instruction in a variety of ways. In 1966, San Bernardino Valley, California, College reported using the computer in diagnosis, in instruction, in evaluation, and in research as part of their college reading improvement program. Harvard personnel described the segments to be programed in Project ORACLE in 1970. About the same time (1969-1970), North Carolina State University was seeking to determine the applicability of computer use to adult basic education.

Nashville State Technical Institute used the computer in scoring a comprehension-based informal reading inventory, in writing prescriptions, and in monitoring student progress. In that same year (1971) a computer-aided remedial English program was tried at Bernard Baruch College of the City University of New York; CATTS (a tutoring and testing system) was being used at Pasadena, California, City College; and a similar program, CBI, was in use at the University of Buffalo. Also in 1971, Northwestern University tried out computer simulation

as a mean of training educators in diagnosis. The results were said to be promising.

Quiz based instruction, such as in the basis of CMI, was made easier by a computerized concept sampling procedure reported in 1972. That year, a University of Virginia researcher described his efforts to teach sixth grade remedial reading with a computer providing additional remediation after the child was shown not to have profited from his other instruction. And also in 1972, a CMI reading program was reported to be operative at Christopher Newport College, Newport News, Virginia.

Wang's *Index to Computer Based Learning* (ICBL) listed a number of computer based programs for reading instruction in 1973. According to ICBL, Red Deer College in Alberta was teaching spelling clues with CAI. Project READ, developed at Arizona State University, was in use with elementary and junior high students. A number of programs developed at Harvard University were available through the State University of New York at Stony Brook and a program, READING, designed for EMR children, was under development at Teachers College, Columbia University, where a test battery (SITE) for normal children completing grade one had also been developed. ICBL also listed two computerized early reading programs developed as part of a master's degree thesis at the University of Alberta, although these programs are no longer functional.

The CONDUIT program of the University of Texas was also reported in 1973, making that year a banner year for CAI/CMI reports from colleges. Unfortunately, only one was added in 1974. It introduced CMI as a model for teaching reading to college students.

In 1976, the development of project LERN was reported by representatives of the University of Arizona and TICCIT (Time-shared, Interactive, Computer Controlled Informational Television) was reported by staff members from Brigham Young University, who discussed a computerized college reading instruction program.

In 1977, a letter from the University of Edinburgh described the development of a new program to teach backward children to read, and Teachers College, Columbia University also reported a CAI reading program to be under development. A University of Minnesota letter reported a CAI program, SYLLO, designed to teach syllabication to nine-year-olds. A similar program to teach plurals was reported to be under development, and Human Resources Research reported a large number of exemplary college reading CAI and CMI programs (see reference number 264).

186. Williams, G. *The use of the computer for testing, programing, and instruction.* Paper presented at the National Reading Conference, St. Petersburg, Florida, December 1966.
The computer was said to be in use in 1) diagnosis, 2) instruction, 3) evaluation, and 4) research with the college reading improvement program.

187. Adair, J.B. Computer assisted instruction in adult basic education in J.A. Mangano (Ed.), *Strategies for adult basic education.* Newark, Delaware: International Reading Association, 1969.
CAI selling points are: 1) instructional programs may be prepared to meet the differing needs of the individual, 2) computer programs can carefully sequence materials, 3) CAI can provide immediate feedback, 4) continuous diagnosis is made easier, and 5) more students.

188. Adair, J.B. *The use of modern educational technology for instruction of undereducated adults.* Research report. Raleigh: Adult Learning Resources Project, North Carolina State University, 1969.
Contains reviews of a number of research reports on CAI. The goal was to generate research questions related to applying CAI in Adult Basic Education.

189. Serwer, B.L., & Stolurow, L.M. Computer assisted learning in the language arts. *Elementary English*, 1970, *47*, 641-650.
Describes plans for ORACLE computer aided language experience reading program, and relevant activities for children.

190. Watkins, L. Computers on campus: Three reports on what they're doing, what they can do. *College and University Business*, 1970, *48*, 71-73.
Reports that in 1969 thirteen of the fourteen smallest colleges surveyed had computer facilities available for faculty and student use, while all but two of the large institutions also made computer services available.

191. Muller, V. *A case for early reading.* Unpublished M.Ed. thesis. University of Alberta, 1971.
Describes 1970-1971 field test of AUPER, a preschool CAI sight word reading program using the IBM 1500 computer facilities of the University of Alberta. Three-, four-, and five-year-old children chose pictured objects on the CRT by pointing the light pencil at the screen. Instantly, a picture of that object was displayed on an image projector under the control of the computer. Under the picture was the printed word naming it. An audio message related the printed word to the picture. Then the word appeared on the CRT and the child was challenged to name it. Eventually the child chose from as many as four printed words displayed on the CRT, to match the picture shown by the image projector. Built-in branching provided remediation presentations. A field test showed the program to be successful in teaching its 40 words to two of the three children with whom it was tried.

192. Wares, M.B. *Use of the computer in individualized remediation at Nashville State Technical Institute.* Paper presented at the National Reading Conference, Tampa, Florida, December 1971.
Designed to provide remediation in mathematics, reading, and English, this program provides computer management for a reading

instructional system featuring an IRI (scored only on comprehension), followed by computer scoring, prescription writing, and monitoring student progress.

193. Bossone, R.M., & Weiner, M. *Three modes of teaching remedial English: A comparative analysis: A pilot study*. New York: City University of New York, Bernard Baruch College, and Graduate School and University Center, 1973.
Compared computer based basic skills in English program to more traditional versions. Found no differences in achievement.

194. Lerner, J.W. *Computer simulation: A method for training educational diagnosticians*. Paper presented at the annual conference of the International Reading Association, Atlantic City, April 1971.
Through computer simulations, students at Northwestern University were able to diagnose reading disabilities of a nonexistent child who "attended" the clinic, was diagnosed and treated, and who responded differently to different treatments. Students tested, observed and wrote reports; the authors thought the technique had promise.

195. McMullen, D.W. *A concept sampling procedure for quiz oriented instruction*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, February 1972.
The computer program sampled text from college materials in order to generate wordlists for content area vocabulary instruction. Students trying the program endorsed it.

196. Strang, H.R. An automated approach to remedial reading. *Psychology in the Schools*, 1972, *9*, 433-439.
A program of automated remedial reading instruction was made available to grade six students as soon as they failed any classroom reading tasks. Children making use of this program outperformed controls in word accuracy and task completion.

197. Randall, A.F. A computer managed reading laboratory program. *Reading World*, 1972, *11*, 286-295.
Describes development and implementation of a simple CMI reading efficiency program at Christopher Newport College. The cost of development was $100. Costs were estimated at $112 for one year of use for 150 students.

198. Wang, A. *Index to computer based learning*. Milwaukee: Educational Media Laboratory, University of Wisconsin, 1973.
All of the computer based learning programs reported in time for publication are listed and described in this index. Seven reading programs were reported to be available from L.M. Stolurow, State University of New York at Stony Brook. These are as follows.

RHYME: A dialogue program to test comprehending main ideas, finding purposes, drawing inferences, getting meaning from context, and recalling details.

DRILL I: A diagnostic reading cloze test presented by controlled slides.

VIPCON: A diagnostic instrument to detect visual preception problems.

PHONIC: A slide tape, computer controlled drill and prac-

tice program in word recognition for children in grades one to three who are having difficulty learning to read.

CONTEXT: Drill and practice questions keyed to the *Using the Context* series (grades one to six).

CONTEXT (Placement test): Prescribes which book to use from the *Using the Context* series.

One listed program, "Survey of Reading and Study Efficiency," was developed at Loyola University of Los Angeles. It was designed to involve the pupil with the computer through inquiry, dialogue; and prescriptions of texts, manuals, and audiovisual presentations. The purpose was to improve study skills of college students.

Two were listed as being developed at Teachers College, Columbia University.

READING: Drill and practice, gaming, and simulation used to teach initial reading to EMR students.

SITE: A test battery for determining end of grade one reading achievement.

Other references to reading programs in ICBL are not reported in this section because they were reported fully elsewhere.

199. Newman, I. *A systematic approach to the use of instructional objectives as an aid in teaching.* Paper presented at the Ohio College Council of the International Reading Association Conference, Dayton, April 1974.

Introduces a General Teaching Model for teaching reading to college students through specifying quantifiable objectives. As an example, an individualized CAI reading program is described.

200. Huelsman, L.P.; Knief, L.M.; & Tuiten, J: *CMI with a new twist.* Paper presented at the annual meeting of American Educational Data Systems, Phoenix, May 1976.

Presents PROJECT LERN, a four part CMI useful to all instructors including reading course instructors. The parts include 1) routing (or placement) based on internal criteria, 2) tutorial lessons, 3) problem application and feedback, and 4) a monitor (a computerized course outline) to be followed by the instructor.

201. Howe, J. Personal letter, June 10, 1977.

Reports progress at University of Edinburgh in teaching backward children to read using a touch screen device, against which slides are rear projected. Children utter names of pictured objects, learning to associate the uttered sounds with the letters projected on the screen. Correct choices result in information confirming the correctness. Incorrect choices lead to presenting a contrast between the choice made and the correct choice. Six of six children have learned to use word attack skills with the computer and five of six have transferred their skills to the classroom.

202. Blackman, L.S. Personal letter, April 8, 1977.

In 1977, Teachers College, Columbia University, was creating pilot programs in CAI reading, but none were available for distribution at the time of writing.

203. Lopez, A.A. Personal letter, April 5, 1977.
SYYLO was developed by L. Classen with the aid of a small grant from the University of Minnesota foundation. Written in the Minnesota Interactive Language (MIL), SYLLO has five steps: 1) Human teaching that every syllable has a vowel sound; 2) an on-line computer pretest, called a "check-in," tests each of seven tasks with three words and then routes learners to any tasks not mastered; 3) instruction is with worksheet type displays for practice tasks, displayed by the computer after a random choice from a word bank; 4) an on-line checkout test is taken; 5) a game called "Syllo" can be played when the program is completed (or tested out of).

204. Bitter, G.B. Personal communication, September 26, 1977.
Points out that Project READ, a dialogue program teaching third reader level skills to upper elementary and junior high pupils with teletype terminal, was being updated at Arizona State University and was, therefore, unavailable.

205. Hunka, S. Personal communication, October 7, 1977.
Reports little use of AUPER (see Muller #192) in the past four years. Also states that EXPER, a phrase reading program for deaf children, has had no extensive use in the past four years. However, at the time of writing EXPER was being reviewed for possible use in a school for the deaf and a new program (based on the Distar model) in basic phonics and sound blending was under development with approximately 45 of a projected 160 lessons completed.

Additional References

206. Williams, G. Use of the computer for testing and programing in a reading program, in G. Schick & H. Merrill (Eds.), *Junior college and adult reading programs*. Sixteenth Yearbook of the National Reading Conference, 1967.

207. Roberts, A.D., & Zirkel, P.A. Computer application to instruction. *Journal of Secondary Education*, 1971, *46*, 102.

208. Yett, E. *Computer assisted tutorial and testing system* (CATTS). Pasadena, California: Pasadena City College, 1971.

209. Stolurow, L.M. *Computer assisted vocabulary acquisition: A terminological approach*. Final report. Stony Brook, New York: State University of New York, 1973.

210. *Computer assisted instruction applied to English spelling. Instructor's manual and implementation manual.* Alberta, Canada: Red Deer College, 1973.

211. Spache, G.C. *College adult reading—past, present and future.* Paper presented at the National Reading Conference, Los Angeles, December 1968.

212. Cole, J.L. *The application of computer technology to the instruction of undereducated adults. Final report.* Raleigh: Adult Learning Center, North Carolina State University, 1971.

213. Strang, H.R. The automated instruction of practical reading skills to disadvantaged sixth grade children. *Improving Human Performance*, 1975, *4* (2), 43-52.
214. Robbins, W.E., & Tharp, A.L. A natural language computerized instructional system for elementary education. *Educational Technology*, 1976, *16* (3), 32-36.
215. Warlick, C.H. Computers in instruction. Austin: Computation Center, University of Texas, 1973.

Chapter 3

PUBLIC SCHOOL APPLICATIONS OF COMPUTERS TO READING INSTRUCTION

After more than a year of searching, the list of school districts implementing computers in some phase of their reading programs is still not exhaustive. We have found articles and reports of CAI and/or CMI reading programs which have been tried (and/or rejected, modified, and retried) and/or which have (fortunately) even succeeded in many school districts, including most of the larger ones. New York, Philadelphia, Chicago, Boston, Los Angeles, Dallas, Montgomery County (Maryland), and Portland have released reports relating their efforts in this area.

Several medium and small school districts have also tried computer based reading programs: Rapides Parish, Louisiana; Mineola and Poughkeepsie, New York; Fresno, Fremont, Sequoia, and Los Nietos (of Los Angeles) Unified School Districts, California; and Wakulla and Jefferson Counties, Florida. Most have continued their efforts. Several intermediate units have provided computer based reading programs for the cooperating groups of schools they served. Many other schools, states, and intermediate school service agencies have also, undoubtedly, undertaken to provide computer service to their reading programs without publishing their efforts in such a manner as to draw our attention. Still others are now developing such programs.

The annotated references which follow will, therefore, provide only a partial description of the tremendous activity generated in school reading programs by the advent of the computer age. This will become even more evident in the following section, Computer Based Reading Services for Sale.

Annotated References

216. Farber, I.J. *The development and implementation of a multilevel management information feedback system.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, February 1974.

Describes the Philadelphia school system's development of a multilevel management information feedback system (CMI) to monitor the operation of the reading programs in its eight subdistricts. The major steps involved were: 1) the determination of information needed; 2) the development of noninterruptive information collection procedures; 3) the design of display formats; and 4) the writing of computer programs employing the district's inhouse computer facilities to generate information useful at the same time to classroom, school, and district administration levels.

217. Farber, K.J. Personal Correspondence, October 24, 1977.

Explains that it has been found inadvisable to combine in a single system classroom instructional information with school and system management information. In 1977, a series of instruments (available on demand) were available for computer processing by NCS scanning of response sheets upon which could be recorded any multiple-choice test responses up to 60 items.

Management information about pupil's reading is provided to the system through a set of bar graphs drawn by the computer. Information to the teacher is provided through printouts showing each pupil's answers to each item as either a plus (correct), or as the letter representing the correct answer for that item.

Among the computer processed instruments available to teachers are several levels of the *Sight-Sound Inventory*, the *Phonics Inventory* (initial and final consonants), and the *Informal Reading Inventory for Secondary Schools.*

Also computer processed are Individual Pupil Service Forms which have been piloted for possible future use in keeping track of the reading levels, the reading materials used, the supplementary reading services in which pupils are involved, the time allotted to reading instruction each week, the manner in which the classroom was organized for reading instruction, their Title I eligibility, and the number of days they were absent. This form will probably not be used, however, since one per pupil is required and the processing of 265,000 forms is prohibitive. In the meantime, classroom reading resources are summarized by computer from Classroom Reading Resource Data Forms filled out by the teacher for each reading class.

218. Diamond, J.J. *A report on project grow: Philadelphia's experimental program in computer assisted instruction.* Philadelphia: Philadelphia School District, Office of Research and Evaluation, August 1969.

Computer assisted instruction (CAI) in developmental reading was operative in four secondary schools in Philadelphia. The achievement of the students in CAI was compared with comparable students in traditionally instructed classes. The results of the standardized reading tests were equivocal. Although the CAI classes performed significantly better than comparable students in traditional classes, an attitude survey constructed for the project indicated that the pupils liked working with the machines, but were frustrated when the system did not function properly. A discussion of the project, including the results of nonstandardized achievement tests and an analysis of the pupils' responses while interacting with the computer, is included.

The project was continued with students in the ninth and tenth grades who are reading below grade level. (According to a printout enclosed by Farber [see previous reference], five secondary schools offered CAI reading instruction to some 37 classes in 1975-1976).

219. Charp, S.A., & Wye, R.A. Computer assisted instruction in a large school system. *Journal of Educational Data Processing*, 1969, *6* (1), 28-39.

Describes the first large school system (Philadelphia) implementation of computer assisted instruction, which included more than 200 hours of reading delivered to four schools. The central processor was (at the time of the writing) a Philco-Ford 102 which was interfaced to eight terminals. The author language used in creating the lessons was INFORM. Units (emphasizing comprehension) were as follows:

Recognition of sentences
Recognition and utilization of key words
Labeling and categorizing concepts
Seeing the relationship between sentences and sentence order
Ordering and sequencing ideas and sentences
Distinguishing general from specific topics
Finding and understanding supporting details
Selecting topic sentences
Drawing sound conclusions
Following directions

Points out that 254 hours of effort were required to create one hour of CAI, but that efficient use is reducing long range costs per student, and that the school district of Philadelphia was considering formation of a computer services network with neighboring school districts.

Additional Reference

220. Charp, S.A. Computer assisted instruction in reading. *Scholastic Teacher*, 1968, *8* (12), 13, 16.

Chicago Public Schools

Annotated Reference

221. Lilman, G.H. *CAI in Chicago*. Paper presented at the annual meeting of the Association for Educational Data Systems, New Orleans, April 1973.

The Chicago Public Schools' CAI program has involved 12,000 students per day working in basic skills (reading, language arts, math) at over 850 terminals. The coursework was developed by Computer Curriculum Corporation and results warranted expansion of the program to the secondary schools in the fall of 1977. Previous research indicated student gains of at least one month for each month in the program.

Fremont, California, Unified School District

Annotated Reference

222. Eller, L.M. Individualized learning using TV. *Educational Broadcasting*, 1975, *8* (4), 27-30, 42.

Individualized learning using TV controlled by computer has been implemented in the Fremont, California, Unified School District. The system provides TV and computer support (in what appears to be a pilot program) to four participating schools whose locations form a diamond over the area from San Francisco to San Jose and from Fremont to Belmont. (The proximity is necessary because of the microwave television signal sent to some of the schools participating.)

The instructional phase of the program is based on Prescribed Activities for Learning (PAL) with its 138 reading programs. A teacher decides on a specific program selected from the Reading PAL and, depending on the AV facilities at the school, uses a monitor that receives a microwave TV signal from a base station or utilizes a video cassette. For reception of micro TV signals, each participating school has its own tower, receiver disk antenna, down converter, power supply, and an amplifier. TV signals and videocassettes can be used in combination.

Fresno, California, Unified School District

Annotated References

223. Lister, W., & Williams, J. *Fresno reading program with computer assistance*. Paper presented at the Rocky Mountain Regional Conference of the International Reading Association, Salt Lake City, November 1977.

Described the development of a management program which involved stating behavioral goals, developing criterion tests of reading skills, and programing computers to print out recommendations to teachers. High pupil mobility created the need for systemwide management, even though diverse instructional materials are in use.

The first testing is with a locally developed informal reading inventory. This inventory indicates the level at which skills are to be assessed with the system's criterion reference tests. These arrive in classrooms with student names preprinted to insure administration to the proper students. Also provided are skill check tests to be administered and scored by teachers as children practice skills prior to taking a criterion referenced (and computer scored) postassessment.

Children in grade two or above use machine scorable answer sheets. First grade children mark on the tests. Their tests are then converted to "bubblecards" (machine readable) by paid aides. The bubblecards are batch processed during night hours (computer time rented by the school district). Tests and printouts are delivered by the Fresno Unified School District's own internal mailing system. Usually a twenty-four hour turnaround time can be maintained.

This system enables teachers to receive diagnostic-prescriptive information about reading levels and skills of students transferred into their classrooms from another school within the system. The basal readers in use in the system (and for which the computer managed program is designed) are those of the Holt Basic Reading System and the Houghton Mifflin Readers.

224. *Continuum of performance objectives, levels R through VII.* Fresno, California: Fresno Unified School District, mimeo, n.d.
Sketches continuous progress program, outlines procedures used in implementing it, itemizes the skills tested, and provides a flow chart of the system as well as sample printouts, tests, and bubblecards (machine readable answer sheets).

Montgomery County Schools, Rockville, Maryland

Annotated References

225. Dunn, A. (Ed.). *Computer assisted instruction program. A three year report covering July 1, 1971, through June 30, 1974.* Rockville, Maryland: Board of Education, Montgomery County Schools, 1974.
Describes the CAI program begun in 1968. The project was federally funded until 1971. Since that time other sources of funding have contributed. During 1971-1974, an elementary reading curriculum was developed which emphasized decoding skills and related skills such as rhyming.

226. Morgan, C.E. Personal letter, October 25, 1977.
Pointed out that early efforts to program CAI reading were unsuccessful because of unsatisfactory audio support for the computer terminals, and adds that in 1977-1978 a new effort was underway.

227. Bernardo, C.M. *Memo to members of the board of education.* Rockville, Maryland: Montgomery County Public Schools, June 30, 1977.
Describes the development of a system for computer management of the reading program over nine school grades. The system was to make use of standardized tests already required (Iowa Tests of Basic

Skills, the Stanford Achievement Test, and the Maryland Functional Reading Test). It was also anticipated that system-developed cloze tests might be used twice per year as a means of monitoring reading progress of students.

Mineola, New York, Junior High School

Annotated Reference

228. Handler, H. The computer comes to the English classroom: Computerized monitoring of pupil progress in reading. *Educational Technology*, 1975, *15* (11), 34-35.

AIMS, a CMI program developed at the New York Institute of Technology, has been in use at Mineola Junior High School since 1969. The system provides no instruction and is designed to diagnose, prescribe, monitor, and evaluate pupil progress in reading. The program maintains records of student achievement in eleven areas: 1) finding main ideas; 2) making inferences (drawing conclusions); 3) noting and recalling details; 4) recognizing sequences; 5) following directions; 6) finding context clues; 7) finding information—study skills; 8) decoding word analysis; 9) recognizing affixes and roots; 10) recognizing synonyms, antonyms, and homonyms; and 11) using syllabication.

Boston School System

Annotated Reference

229. Innovative implementation of computer aided instruction. In L.A. Harris (Bibliographer) *Title III Pace Projects in reading*, Volume 2. Bloomington, Indiana: Eric Crier Reading Review Series, 1969.

Describes the Boston, Massachusetts, program, designed to develop diagnostic reading programs for elementary and secondary students in urban areas. The program was planned to serve 11,000 students.

New York City Schools

Annotated References

230. The terminal is the best friend I know.... *Reading Newsreport*, 1970, *4* (3), 32-35.

Using an elementary English program designed by H. Wilson at Harcourt Brace Jovanovich, Melvin Mendelsolm (then Director of CAI for New York) suggested that the following year New York City Schools would be using CAI reading.

231. Films on CAI. *Educational Technology*, 1969, *9* (7), 59.

Describes film available from RCA. The film showed a 192 station CAI program serving 16 New York City schools. The consultant was listed as P. Suppes.

Additional References

232. Wilson, H.A., & Fitzgibbons, N.H. Practice and perfection: A preliminary analysis of achievement data from the CAI Elementary English Program. *Elementary English*, 1970, *47* (4), 576-579.
233. Butler, C.F. CAI in New York City: Report on the first year's operation. *Educational Technology*, 1969, *9* (10), 84-87.

Dallas, Texas, Independent School District

Annotated Reference

234. Students use talking computer in Dallas bilingual program. *Phi Delta Kappan*, 1977, *59* (4), 234.

Describes an ESEA Title VII and Title IV-C program which uses a computerized voice synthesizer to reinforce reading and language programs called ROLL and BOLAR. Students work in groups of five for ten minutes, three times per week.

Eastern Kentucky Development Corporation

Annotated References

235. Brown, H.P. Personal letter, March 29, 1977.

Describes CAI program implemented with teletype terminals in a number of schools in the Eastern Kentucky area. The corporation worked with RCA's computer division and Stanford University. The software was distributed by Harcourt Brace Jovanovich. The program was discontinued in 1972.

236. Mynhier, B. *The impact of federal programs on learning to read in Appalachia.* Paper presented at the annual conference of the International Reading Association, Kansas City, 1969.

Describes ESEA Title III CAI program in 20 counties in Eastern Kentucky.

237. *Reading; drill and practice teacher's manual.* Ashland, Kentucky: Eastern Kentucky Educational Development Corporation, 1972.

Provides the teacher with directions for using the CAI program to supplement classroom reading instruction. Explains how teachers can call lessons, how students enter the program, and how the teacher is informed of student progress and problems. Gives a complete list of decoding skills, sentence skills, and comprehensive skills practiced by students working at the terminals provided.

New York State Education Department

Annotated References

238. O'Reilly, R.P. *New York state bank of reading objectives.* Paper presented at a joint meeting of the Measurement in Education and American Educational Research Association, New Orleans, February 1973.

The paper presented the rationale, structure, content, and procedures for the computerized bank of reading objectives then being developed for New York state schools. The project was initiated to provide a technical resource which would contribute to planning, design, and evaluation of reading programs. The paper defines the organizing concepts for the project, including a generalized format for writing objectives, a procedure for organizing the generic form of objectives into summative criterion objectives, a structure for scaling reading intent and associating it with objectives.

239. O'Reilly, R.P. Computerized banking as a resource for systematic program development and evaluation in reading. *Educational Technology*, 1973, *13* (9), 38-40.

SPPED (System for Pupil and Program Evaluation and Development) was a research and development project of the New York State Education Department. The SPPED program included both CAM (Comprehensive Achievement Monitoring) and SCAN (Systems Coding Analysys), parts of a comprehensive instructional management system designed to aid several major program development functions in education: planning, design, installation, evaluation and the transmission and use of evaluative information. The bank stores 1800+ specific reading objectives for kindergarten through twelfth grade.

240. Cohen, A.S., & Bednarik, J. *SCAN (Systems Coding Analysis) computerized analysis of reading behaviors*. New York: Random House Educational Systems Division, 1974.

SCAN is a set of instructional reading objectives. This set was developed to coincide with a criterion performance assessment program. SCAN and the computer allow a matching of 1) reading behavior, 2) reading test times, 3) instructional materials, and 4) instructional objectives. This allows efficient and affective matching of student reading behavior with expected or anticipated reading behavior, and with appropriate instructional and assessment materials.

241. Computer tutor. *American Education*, 1976, *12* (5), 4.

Described Tel-Catch, a pilot program then serving homebound school children in New York State. 100 children were enabled to dial the master computer (or central processor) by phone, place the phone on the coupler, type out a lesson request, and get videoscreen "pages" to read and respond to. Teachers were on standby to help with the more than 2,000 lessons available to choose from.

Red Bank, New Jersey, Schools

Annotated Reference

242. Let your fingers do the learning. *Reading Newsreport*, 1972, *7* (2), 26-29.

Operation Bookstrap (simulated CAI) was carried out in 1971-1972 by Red Bank elementary schools with the cooperation of Bell Telephone Laboratories. First and second graders dialed words they didn't know on touchtone telephones. The word was decoded, spelled aloud, and pronounced for the child on the telephone. The project was discontinued for lack of funds.

Billerica, Massachusetts, Schools

Annotated Reference

243. Serlin, J. Good grief! Charlie Brown's computerized! *Reading Newsreport*, 1970, *4* (6), 29-30.

Describes program of computer assisted primary reading at Parker Elementary School. Nearby high school students did the question writing and the programing on their leased IBM 1130. The young pupils answered these questions after off-line reading of their school reading books. Reinforcement messages were given to young subjects when they responded correctly. Encouragement was given and they were urged to try again after an error.

Sierra Vista, Arizona, Schools

Annotated Reference

244. Feugate, J.T. *Computer aided instruction in Sierra Vista, Arizona, elementary schools.* Paper presented at the annual meeting of the Association for Educational Data Systems, Phoenix, May 1976.

Described ESEA Title I program of both CMI and CAI reading. The CAI was a drill and practice program for grades three through six.

Poughkeepsie, New York, Shared Educational Computer System

Annotated Reference

245. Dunwell, S. *Report on WRITE: A CAI course in written English usage.* Poughkeepsie, New York: Shared Educational Computer System, 1972.

An experiment utlizing a CAI spelling and word usage program delivered via teletype terminals to Poughkeepsie, New York, middle schoolers (fifth through eighth grades). The instruction stressed spelling patterns rather than individual words. Results indicated CAI was an effective means of teaching spelling.

Rapides Parish, Louisiana, Schools

Annotated References

246. *Individualized reading instruction for students (IRIS).* Alexandria, Louisiana: Rapides Parish School Board, pamphlet, n.d.

A Title III (ESAA) funded CMI project providing for diagnosis of reading needs, location of materials for treatment, and the monitoring of progress—all with computer assistance.

247. *Individualized reading instruction for student computer managed reading system: Validation report.* Alexandria, Louisiana: Rapides Parish School Board, 1977.

The project provided locally constructed diagnostic tests, computer indexed teaching materials, criterion referenced tests, and periodic

summaries of progress for individual students, classes, and schools. The first and second years of the project were used for development and field testing of the various components; the third year was used to implement the program and to investigate its effectiveness. Results from a comparison of 196 pupils from grades three, four, seven, and nine with 143 pupils on control groups are reported for student achievement.

Kansas City, Missouri, Schools

Annotated Reference

248. Taylor, S.S. *A comparison of two public school computer assisted instruction projects.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1972.

Describes short, half-hour, single concept enrichment lessons that allowed a student to bypass a sequence if his pretest performance indicated concept mastery. Developed in Kansas City, these CAI lessons were structured to reduce the redundancy that frequently causes students to progress slowly in programed materials.

Yorktown Heights, New York, Schools

Annotated Reference

249. Reading 1604. In A. Wang (Ed.), *Index to computer based learning.* Milwaukee: Instructional Media Laboratory, University of Wisconsin, 1973.

A listing of a Title III CAI program for word and letter recognition. The presentations were both auditory and visual and involved both upper and lowercase letters.

Additional Reference

250. When computers work overtime. *Reading Newsreport*, 1970, *4* (3), 30-31.

Los Nietos School District of Los Angeles County

Annotated Reference

251. Reading 1743. In A. Wang (Ed.), *Index to computer based learning.* Milwaukee: Instructional Media Laboratory, University of Wisconsin, 1976.

Lists elementary and junior high CAI drill and practice reading programs in Whittier, California, as operational. The program is entitled the ESAA Basic Program.

252. Crandall, N.D. Personal communication, March 25, 1977.

Notes that Los Nietos was using 44 terminals and anticipating increasing the number to 84 for drill and practice in reading, math, and language arts. By so increasing, the system would allow each child

20 minutes per day at the terminal. It is reported that CAI is cost-effective and that in the first two years mean CTBS scores rose from the 10th to the 38th percentile. The programs used are those of the Computer Curriculum Corporation (see Chapter 5).

253. CAI gets credit for dramatic achievement gains for minorities. *Phi Delta Kappan*, 1977, 59 (4), 290-291.
Reports project director's report to a House of Representatives panel, and cautions in interpretation urged by a college computer expert.

Multnomah County, Oregon, Intermediate Education District

Annotated References

254. Reading 1744. In A. Wang (Ed.), *Index to computer based learning*. Milwaukee: Instructional Media Laboratory, University of Wisconsin, 1976.
This Portland, Oregon, program is entitled "Parkrose CMI Reading." It provides computer assistance for an elementary school reading management system.

255. Cooper, M.K., & Tobey, G.R. *A computer management support system for IGE*. Paper presented at the annual meeting of the Association for Educational Data Systems, Phoenix, March 1976.
Described the implementation of a CMI system based on the Wisconsin Design for Reading Skills Development in one school in Portland, Oregon.

Los Angeles, California, Schools

Annotated Reference

256. Reading. In H.A. Lekan (Ed.), *Index to computer assisted instruction*, third edition. New York: Harcourt Brace Jovanovich, 1971.
Lists CMI program developed to help manage reading program with Ginn Basal Readers.

Cincinnati, Ohio, Public Schools

Annotated Reference

257. Morgan, M.M. *Computer assisted instruction for the blind and deaf*. Paper presented at the annual meeting of the American Educational Research Association, Washington, D.C., April 1975.
Describes a Title III project in Cincinnati. Special education teachers were trained to prepare CAI lessons and to monitor children trying them out. CAI was found to be beneficial to hearing impaired children. Attitude measures indicated that teachers, students, and parents reacted favorably to CAI use.

Memphis, Tennessee, Public Schools

Annotated Reference

258. Joiner, Lee. Personal communication, December 15, 1977.
CAI in both reading and mathematics was tried in the late sixties. Curricula available from the Computer Curriculum Corporation and from Harcourt Brace Jovanovich were used. The results in math were superb, while the reading results were equivocal. Therefore, the school district decided to use the CAI program for what it taught best—mathematics. In 1977, 64 terminals were in use for mathematics.

Pontiac, Michigan, Schools

Annotated References

259. INDICOM. *(Individual Communication System). Final Report.* Pontiac, Michigan: Waterford Township School District, 1970.
The report is a complete description of the CAI project in reading and mathematics for grades four and five. Rationale, instructional strategy, development and implementation as well as potentials and conclusions are discussed.

260. Hannan, T. Computer assisted instruction—State of the art summary. *Audiovisual Instruction*, 1970, *15* (6), 93-94.
A review of an INDICOM progress report.

Norfolk, Virginia, Schools

Annotated Reference

261. Tokar, E., & Ford, V. *Effectiveness of an ESAA funded information feedback system on the reading and arithmetic achievement of black and white fifth grade pupils.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, April 1976.
The authors used a computer system called MIFS (Multiethnic Information Feedback System) to monitor performances in reading and math and to evaluate both the needs of the students and the effectiveness of the instruction. Results indicate the MIFS program significantly increased reading and math achievement.

Mason, Michigan, Capitol Area Career Center

Annotated Reference

262. Danford, J. CMI at Capitol Area Career Center, Mason, Michigan, in H.E. Mitzel (Ed.), *An examination of the short range potential of computer managed instruction: Proceedings of a conference.* Chicago, November 1974. (ED 112-943)
A Univac 70/2 COBOL program analyzes job information and manages

instruction. Individuals receive individualized learning packets which spell out the necessary job objectives. Basic skills testing and evaluation for each individual are related to those necessary job related skills, and a program of training is developed.

Other Public Schools

Annotated Reference

263. Seidel, R.J., & Hunter, B. *Academic computing directory: A search for exemplary institutions using computers for learning and teaching.* Alexandria, Virginia: Human Resources Research Organization, 1977.

The directory, compiled in part from a NSF grant, summarizes many elementary and secondary public school computer managed and computer assisted reading programs. Included are Sierra Vista, Arizona; Los Angeles, Whittier, Atherton, Newport Beach, Palo Alto, East Palo Alto, San Francisco, Redwood City, and Escondido, California; Lakewood, Colorado; Greenville, Delaware; Washington, D.C. (Gallaudet College, Kendall Demonstration Elementary School); Chicago, Illinois; Shawnee Mission, Kansas; Alexandria, Louisiana; Westford, Massachusetts; Mason, Pontiac, and Waterford, Michigan; Hopkins, Minnetonka, Bloomington, and St. Paul, Minnesota; Omaha, Nebraska; Teaneck, New Jersey; Albuquerque, New Mexico; Brooklyn, Williamsville, Freeport, Edinger, Guilderland, DeWitt and Centereach, New York; Dayton, Cincinnati, and Peninsula, Ohio; Portland, Oregon; Memphis, Tennessee; Bryan, Dallas, and Richardson, Texas; Sardy, Utah; Norfolk, Virginia; Seattle, Washington; and Madison, Wisconsin.

Chapter 4

COMPUTER ASSESSMENT OF READABILITY AND TEXTBOOK ANALYSIS

Computers can quite easily be programed to count letters, words, lines, sentences, and marks of punctuation. And some computer programs do just that. By counting words per sentence and percentage of hard words, the Fry formula can be applied. Two programs do apply the Fry formula. With the same sort of count and the addition of a constant, the Dale-Chall readability formula can be computed. Three programs do compute it. The Navy Automated Center approximates the Flesch formula estimate. Four other computer programs can apply the Flesch formula. An Oregon project has developed a program which simultaneously computes four readability coefficients.

By counting letters per word and matching that statistic with syllables counted by humans, computers have derived formulas for predicting letters per syllable and constants to be used to estimate syllables for those formulas requiring a syllable count. For those syntactic components, a computerized measure of syntactic density has been created and tested. And for those interested in comprehension, a computer selection of key words has been designed. Finally, a system for computer abstracting of text has been developed.

Some of these computerized programs use well known computer languages such as FORTRAN. Others, such as TEXAN, are programing languages all by themselves. Very few have actually designed computer readability programs to provide estimates of the reading difficulty of materials which were written for school children. More frequently the programs were created to aid the researcher in classifying materials or generating new materials for studies in reading comprehension.

Annotated References

264. Barry, J.B., & Stevenson, T.E. Using a computer to calculate the Dale-Chall formula. *Journal of Reading*, 1975, *19* (3), 218-222.

Explains rapidity and accuracy of calculating textbook readability levels by computer.

265. Bunde, Gary R. *An effective evaluation between manual and automated readability counting techniques.* CNETS Report Number 5-75. Pensacola, Florida: Naval Education and Training Command, 1975, 33 pp.
The Automated Flesch Count and the Navy Automated Counter were found to be approximately equal in speed and reliability.

266. Coleman, M., & Liau, T.L. A computer readablity formula designed for machine scoring. *Journal of Applied Psychology*, 1975, *60* (2), 283-284.
Points out that there is no need to count syllables, since word length in letters is a better predictor than word length in syllables. The formula then generated uses letters per 100 words and sentences per 100 words.

267. Coke, E.U., & Rothkopf, E.Z. Note on a simple algorithm for a computer produced reading ease score. *Journal of Applied Psychology*, 1970, *54*, 209-210.
Compared Flesch Reading Ease Scores based on syllable counts by humans with computerized scores based on vowels per word, consonants per word, and letters per word (in place of syllables). A correlation of .92 was found between scores based on syllable counts and scores based on vowels per word.

260. Harris, A.J., & Jacobson, M.D. Predicting twelfth graders' comprehension scores. *Journal of Reading*, 1976, *20* (1), 43-46.
Describes predictive validity of Harris-Jacobson formulas, which are complex and thus require computer processing.

269. Jacobson, M.D., & MacDougall, M.A. *A computerized model of program structure and learning difficulty.* Paper presented at the annual meeting of the American Psychological Association, Washington, D.C., 1969.
Proposed a computerized system for determining readability or programed materials.

270. Jacobson, M.D., & MacDougall, M.A. Computer management of information and structure in computer supported instructional materials. *Educational Technology*, 1970, *10*, 39-42.
Readability measures can evaluate both student performance and program structure.

271. Felsenthal, H. *Readability: Computer utilization.* Paper presented at the annual conference of the International Reading Association, Denver, May 1973.
Describes the development of TEXAN (Textual Analysis of Language Samples) at Purdue, and the variables TEXAN measures. Estimates were generally close to expected readability levels, but some wide variations were noted. Syllable counts were estimated by dividing average word length by 3.1127 (a constant).

272. Hopkins, C.J., & Moe, A.J. *The validation of a synthetic syllable count appropriate for computer determined readability estimates.* Paper presented at the annual conference of the International Reading Association, New York, May 1975.
Letters-per-syllable constants were derived for use in place of syllable counts in readability formulas.

273. Herndon, M.A. An approach toward computer control of redundancy in textual materials. *Journals of Reading Behavior*, 1976, *8* (3), 259-271.
Describes progress of RDE, a computer program for Redundancy Detection and Editing. With continued progress, the program may offer a less arduous task for partially sighted individuals and foster (less redundant) reading for others.

274. Joos, L.W. *Computer analysis of reading difficulty*. Paper presented at the annual meeting of the Association for Educational Data Systems, New Orleans, April 1973.
Describes an automation of the Dale-Chall Formula for Estimating Reading Difficulty.

275. Klare, G.R. Automation of the Flesch Reading Ease-Readability Formula with various options. *Reading Research Quarterly*, 168-1969, *4* (4), 550-559.
Gives options in computerizing the Flesch Reading Ease Formula and suggests best choices.

276. Koethe, M.E., & Coke, E.U. *A scheme for text analysis using FORTRAN*. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, February 1973.
A discussion of the development of a program which measures complexity of text in word length, sentence length, key word occurrence, and certain style indicators. The uses of such a program are 1) grading essays, 2) identifying sources of response bias in tests, 3) aiding editors, and 4) aiding researchers in establishing text parameters for research in communication.

277. Mockovack, W.P. *The application and evaluation of PLATO IV in AF technical training*. Lowry AFB, Colorado: Technical Training Division, United States Air Force, 1974.
Describes PIRL readability formula and gives results of comparison with other formulas.

278. Moe, A.J., & Arnold, R.D. Computer assisted readability levels of twenty-five Newbery books. *Reading Improvement*, 1975, *12*, 59-64.
Used computerized versions of the Lorge and the Fry Readability Formulas to estimate readability of Newbery books.

279. Stolurow, L.M., & Klare, G.R. *Project CREATES (Combined Resources for Editing Automated to Enlighten Students)*. First Annual Report, 1968-1969. Cambridge, Massachusetts: Harvard University, Computation Laboratory. (ED 032-778)
Two major projects in CREATES related to reading, known as TREE and CAIBLS. TREE encompasses the development of computer aided revisions of adult basic education materials. CAIBLS is the development and implementation of basic language skills and reading materials.

280. Thomas, G.; Hartley, R.D.; & Kincaid, J.P. Test-retest and inter-analyst reliability of the Automated Readability Index, Flesch Reading Ease score, and the Fog count. *Journal of Reading Behavior*, 1975, *7* (2), 149-154.
Six analysts applied three computerized readability formulas to derive scores which were then analyzed for reliability and time require-

ments. All were highly reliable. The Flesch took the greatest amount of time and the Automated Readability Index was easiest to program.

281. Watkins, C.E. READABILITY. A program available from Project CONDUIT, Oregon State University, Corvallis, Oregon.
This program, written in FORTRAN for use with CDC 6400 processor, simultaneously calculates four readability estimates—Flesch, Dale-Chall, Farr-Jenkins-Patterson, and Danielson-Bryan. It is intended for use with communications research.

Additional References

282. Edmundson, H. New methods in automatic abstracting. *Journal ACM*, 1969, *16* (2), 264-285.
283. Rush, J.; Salvador, F.; & Zamora, A. Automatic abstracting and indexing. Production of indicative abstracts by application of contextual inference and syntactic coherence criteria. *Journal of the American Society for Information Sciences*, July-August 1971, *22* (4), 260-274.
284. Carroll, M.N., & Roeloffs, R. Computer selection of key words using word frequency analysis. *American Documentation*, 1969, *20* (3), 277-233.
285. Fang, I.E. By computer Flesch's Reading Ease Score and a syllable counter. *Behavioral Science*, 1968, *13* 249-251.
286. Felsenthal, N.A., & Felsenthal, H. *Utilizing the computer to assess the readability of language samples.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1972.
287. Gillman, D.A., & Moreau, N.A. Effects of reducing verbal content in CAI. *AV Communication Review*, 1969, *17*, 291-298.
288. Golub, L.A., & Kidder, C. Syntactic density and the computer. *Elementary English*, 1974, *51*, 1128-1131.
289. Luhn, H.P. The automatic derivation of information retrieval encodements from machine readable texts. *Documentation and Library Science*, 1959, *3*, 1021-1028.

Chapter 5

SOURCES OF COMPUTER SERVICES

Schools and colleges make use of computer time as it is available. As was pointed out earlier, some public schools use the computer facilities of banks, trucking companies, or nearby colleges to process their data and/or diagnose and prescribe for instructional needs. For schools and school districts without available expertise to computerize their own instructional programs or instructional management systems, a number of companies offer computer programs or computer time (or both) for a price.

At least four kinds of companies have been marketing computer assisted or computer managed reading systems: 1) book publishers who have long served the reading materials needs of schools, 2) test publishers, 3) experts in computer programing and systems development, and 4) manufacturers of computers. (As the reader will soon note, sometimes two or more of the foregoing are combined in one company.)

Each type of company will be discussed separately and annotated references will be presented as appropriate.

Book Publishers

Book publishers are aware of the possibilities and have explored CAI and CMI with many school districts. Tom Beall, a consultant for American Book Company, pointed out that he had worked with the Minneapolis schools on Project PYRAMID, which was to have become a computerized management system but stopped short of computerization.

Addison-Wesley tried publishing the *Ransom Diagnostic and Prescriptive Reading Program* (a CMI system) but gave up and withdrew the program from the market. At the time of this writing the extent of Addison-Wesley's involvement with computers was hiring computer companies to run readability estimates on stories being considered for inclusion in their readers.

Harcourt Brace Jovanovich developed and marketed two CAI reading programs between 1967 and 1971. One of these was *CAI Elementary English*, a drill and practice program designed to supplement basal reader programs in grades four, five, and six. Teachers at any of these three grade levels could select from a 320 lesson sequence those topics fitting their lesson plans and direct the computer to present those lessons to the students. The other program was *CAI Remedial Reading*, a three level sequence of 180 lessons per level for middle and junior high school pupils reading at least second reader level. After initial pretesting, the students were branched into the lessons for their ten to twenty minute daily sessions at the terminals.

Excellent results were achieved with these two programs at several sites. Among those school systems using the Harcourt Brace Jovanovich software (programs) were New York City, Cincinnati, Memphis, Macomb (Mississippi), and Waterford Township (Pontiac, Michigan). More than 3,000 students were on-line with the English program and nearly 1,000 made use of the remedial reading program. However, even though software costs were reduced to only 7.5 cents per student contact hour, the installation and maintenance costs for computer hardware were high and Harcourt Brace Jovanovich ceased marketing these programs.

For some time, the Lippincott Company has been working with schools in Richmond and Roanoke, Virginia, to develop a CMI program for those two districts. However, differences in school district needs and differences in computing machinery have hindered progress there.

Prentice-Hall Developmental Learning Centers have begun merchandising the product once marketed by the Responsive Environments Corporation. One [redacted] is the Edison Responsive Environment (ERE) or Talking Typewriter, a computerized electric typewriter with jumbo sized type, microphones, speakers, and a projection screen. This device was automated by Richard Kobler to take advantage of a methodology developed by O.K. Moore, who used an electric typewriter, a tape recorder, and a slide projector to teach his two year old daughter to read.

There are three phases in the operation of the machine. In Phase I, the machine acts like any other electric typewriter. In Phase II, the typewriter responds to the pressing of a key with a one second sound recording (the keyvoice) which may give the letter name, the phoneme it represents, or any other information which can be imparted in one second. Phases I and II are free phases: the child can press any key. In Phase III, the machine is controlled by computer programing so that

no key can be depressed until it is appropriate to the program for it to be depressed. This locked key feature may be used in conjunction with the keyvoice to provide simultaneous oral and visual stimuli in complex instructional combinations.

The results of using the ERE have been generally favorable whether the target populations were preschoolers, adult illiterates, or poor readers in the intermediate grades. Recently, a method called Oralographic Instruction has been devised for presentation by the ERE. In this 60 lesson program, the student is presented with letter-sounds and symbols which he learns to blend into words. These words are then printed for the student to hear, read (and record), and write for comparison with the machine model. These 60 lessons provide from 120 to 200 hours of instruction.

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An IBM 1050 AV computer system was used to teach four-year-olds word and letter recognition. Tapes and slides were also used. In one experiment sixteen disadvantaged children explored the (typewriter) keyboard for six sessions and then were given matching tasks using words only. In a second experiment, ten children were trained in words only and ten in letters only. No differences were found in word and letter programs, but boys did better than girls in both experiments. In a third experiment with middle class children, there were no sex differences, but letter programs were better than word programs. The author believed the CAI program was too slow to react to student response but that it was good for boys.

291. Reading 1609. In A. Wang (Ed.), *Index to computer based learning.* Milwaukee: Instructional Media Laboratory, University of Wisconsin, 1973.

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have fingernails painted to match fingers to the colors of the keyboard.

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Describes evaluation of an 18-station Edison Responsive Environment system by Prince George's County, Maryland, Board of Education. Twenty-two second and third grade children, who were at least a year retarded in reading, were taught Dolch words and other words from the school's basal readers. The 11 members of the control group used a nonautomated electric typewriter. The ERE group (N = 11) gained two years in reading test norm scores while the control group gained one.

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298. Steg, D.R., & Schenk, R. Intervention through technology: the "Talking Typewriter" revisited. *Educational Technology*, 1977, *17* (4), 45-47.
Describes systematic use of the ERE at Drexel University's Early Childhood Center from 1967 to 1977. Reports studies in which disadvantaged children maintained early gains from using the Talking Typewriter.

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blending) method which can be presented by either the "Talking Typewriter" or the "Talking Page" with the "Voice Mirror." The test scores for thirty one learning-disabled children who completed the program were randomly selected from those tutored or taught in the usual small groups for LD children. The experimental children led their controls by approximately one-half year.

300. Ratekin, N. *The effect of oralographic instruction on the reading achievement of disabled learners: A final report.* West Orange, New Jersey: Prentice-Hall Developmental Learning Centers, 1977.
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Test Publishers

Test publishers make available to their customers a variety of computer-printed scores and reports. Most modern testing companies can produce printouts of results for each child, as well as class summaries for the teachers, school summaries for principals, and system summaries by grade level. Measurement Research Corporation of Iowa City has scored and processed results for both Houghton Mifflin and Harcourt Brace Jovanovich. TRACER, a newly-purchased subdivision of McGraw-Hill, has been assigned the job of computerizing the management of materials developed by McGraw-Hill's California Test Bureau (CTB).

CTB has developed ORBIT, a list of 335 objectives in reading and communication skills. ORBIT (Objectives Referenced Bank of Items and Tests) is made available to school officials who choose the objectives appropriate to their own instructional programs. For each objective chosen, the computer prints four multiple-choice items which make up tests to be given to the school district's pupils. A computer scoring and reporting system is available to provide reports at classroom, school, district, and individual pupil levels.

A subsidiary of IBM company, Science Research Associates (SRA) markets MASTERY: An Evaluation Tool, part of the SRA *Criterion Referenced Measurement Program*. The reading portion of MASTERY (SOBAR reading) was developed by the Center for the Study of Evaluation at UCLA.

School personnel can select reading objectives from either or both of two catalogs (K-2 and 3-9). Once objectives are selected, the computer constructs customized tests of three items per objective. The SRA scoring service provides individual student profiles, list reports (for grouping by skill), group reports (students' performance by objective), and mastery distribution reports (mastery of objective is three correct items). Teachers may use these reports with the *SRA Learning Cycle Guide: Reading K-3* or the *SRA Learning Cycle Guide: Reading 4-8* to match materials to each of the objectives assessed. Then MASTERY can be used for postassessment.

Educational Progress, a division of Educational Development Corporation, markets *Individualized Criterion Referenced Testing* (ICRT). School personnel administer approximately forty tests which are available for grade levels 1-8. Tests are color coded by grade level. Students mark on computer cards which are mailed to the company. Printouts mailed back to the school have three sections entitled "You-

are able to . . . ," "You need to review how to . . . ," and "You need to learn how to . . . ." Under each title is printed the objectives which are appropriate for that title for the particular student. For those objectives listed in the latter two sections, appropriate lessons from the *Audio Progress Reading Laboratory* and *Clues to Reading Progress* are listed along with lessons from many other programs named by the buyer (school). Also available are class, building, and district summary reports for teacher and administrator use.

The Center for Educational Assessment is a division of the Economy Company which has developed a computerized diagnostic and prescriptive program for early childhood education (ages four to seven). ACEPT (Assessing Children for Early Prescriptive Teaching) defines goals; provides tests; and writes prescriptions in the cognitive, social-emotional, and perceptual-motor areas.

Teachers, aides, paraprofessionals, and parents may be trained to give the test. The test administrator marks responses on the score sheet. The marked score sheets are then mailed to the center where the computer scores each test and prints out 1) a prescriptive activity sheet for each child (one for the child's teacher and one for his parents), 2) a class profile sheet for the teacher, and 3) a class record. The company guarantees that prescriptions will be returned to the school in no more than seven days from the date of mailing. The prescription may include 30 to 55 tasks.

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314. Yawkey, T. D., & Lewis, L. *ACEPT: Assessing children for early prescriptive [illegible]*. Oklahoma City: Center for Educational Assessment, Economy Company, 1976.

A 130-item, criterion referenced, individually administered test of pointing, acting-out, answering questions, matching, imitating, repeating after, and identifying pictures. The score sheet is marked by blackening one of three ovals after each item (yes, no, no response) with a number two pencil.

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Computer Programing and Systems Development Companies

Some companies have been formed to market computing expertise and information. ENTELEK (Newburyport, [redacted]usetts), Technica (Salt Lake C[redacted]), National Computer Systems ([redacted]markets WIS/SIM), ENTRAN (Milwaukee), BASIC Timesharing (C[redacted]ll, New Jersey), Minicomputer Systems (Elmsford, New [redacted]ork), [redacted]cational Research Associates (Palo Alto, California), Ti[redacted] Corporation (West Hartford, Connecticut), QUICKTRAN (at [redacted]s in ten large cities), MITRE Corporation (McLean, Virginia), Coursewave (San Diego), ARIES Information Systems (Milwaukee), Bolt, Baranek, and Newman (Cambridge, Massachusetts), and Computersharing (Philadelphia) are a few of the companies.

In the area of computer assisted instruction, the company most often referred to is th[redacted]mputer Curriculum Corporation of Palo Alto. This company [redacted] five CAI drill and practice reading courses, "Reading, Grades 3-6," "Reading 7-8," "Adult Reading Skills," "Reading for Comprehension," and "Critical Reading Skills." Since Patrick Suppes, of Stanford, is president of the company, the programs are strongly influenced by the research and development activity of the Institute for Mathematical Studies in the Social Sciences during the late 1960s.

At the lowest level, "Reading, Grades 3-6" consists of presentations of simple sentences (with as few as two words per sentence), each containing a blank and each followed by three words. The student selects the word and is immediately reinforced for a correct choice. The sentences are said to be of 2.5 to 3.5 level of difficulty. If the student does not respond in 60 seconds, the word *time* appears on the screen or printout and the item is scored as incorrect.

The teacher sets the grade level (to the nearest half grade) at which a child is first to be taught by the computer. During the first ten lessons the computer adjusts upward and/or downward in each of the five strands of the program to find the correct level. After the tenth lesson, the computer presents items from each strand to each student in each lesson. The items are randomly selected from those available at the appropriate level for that particular strand.

When the student has tried all the items at a particular level in any strand, he is moved forward to the next level of that strand *if* he has made no mistakes or only one mistake. If he made one mistake, he moves up a level, but the missed item will be presented again at that higher level. If he missed two items, he will not move up; the missed

items will be re-presented in random order. If he missed three or more items, he will move back and will be presented items from the level below the one in which he had been working in that particular strand.

The five strands are described and a typical item for each part of a strand follows.

Strand A. Word Attack

Letter Discrimination

It's_____ for the movie to start.
tim time

Contractions

He's in the kitchen.
He_____ in the kitchen.
is it

Compounds

A sunburn is a burn caused by the_____
sun moon heat

Prefixes

The color of your hair is determined before you are born.
The color of your hair is_____
prejudiced predetermined precooked

Suffixes

We had a lot of snow here last winter.
Last winter was very_____
foggy snowy rainy

Root Words

That was not really a giant ant in the movie.
The giant ant in the movie was not_____
real red rented

Strand B. Words

Vocabulary

The lofty building blocked out the sun.
"Lofty" means_____
very high made out of glass

Homonyms

An octopus has a large head and _____arms.
eight

Words With More Than One Meaning

Even the handle of the pan is too hot to touch. In this sentence sentence, "handle" means_____

hold or touch with your hands

the part made to be held

Strand C. Literal Comprehension

Transformations

Our school was struck by lightning.

_____stuck our school.

Categories

Which word names a taste?

cave sour typewri

Questions and Answers

Wilson has to wear glasses all the time.

What does Wilson have to wear?

Sequence of Events

Barbara woke up_____ Then she woke Albert up.

last while first

Likeness and Difference

I had a nickel and a penny. Roberta had a dime and a penny.

Who had a dime?

Strand D. Interpretive Comprehension

Synonyms

The noisy crowd ran through the street.

The crowd was very_____

quiet gentle loud

Antonyms

Mark's shoes are loose.

His shoes are not_____

tight ud easy

Fact and Opinion

That man's fur coat looks strange.

This is_____

a fact an opini

Primary Inference

Patricia likes to run in the sn She likes_____

time winter spring

Character Study

Phoebe quickly changed her answer when the teacher frowned.
Phoebe was_____
anxious to be right in a daze

Slanted Writing

Stan borrows from people without paying them back.
Stan thinks everyone should share what they have.
Which sentence makes Stan sound good?

Cause and Effect

A big dog scared Phyllis out of the park.
Phyllis left the park because_____
her father told her to _____she is afraid of big dogs

Analogies

Catch is to miss as win is to _____
prize sit lose

More Interesting Writing

Which sentence is more interesting?
Sandy smacked her lips as she ate the snails.
Sandy enjoyed eating the snails very much.

Metaphors

The cold wind knifed through Alice's thin coat.
The cold wind went through Alice's thin coat like a_____

Strand E. Work Study Skills

Alphabetizing

_____ comes first alphabetically.
Lounge Mercy Prairie

Guide Words and Letters

The word_____comes between the words "blind" and "bring" in the dictionary.
butter bottom beach

Finding Information

To find out if it will be windy tomorrow, you would look in _____
an encyclopedia an atlas a newspaper

Whenever teachers wish, they may call for student and class performance information. The computer will give each student's placement in each of the five strands (if the student has completed a strand, it is so indicated with the word TOP), the amount of time the student has spent

on the program, the number of time-outs for each student, and which used the program on the day of the report.

"Reading 7-8" is a drill and practice program of only two strands, vocabulary and reading comprehension. The vocabulary strand presents practice on 2,250 words at each grade level. The presentations range from providing a definition to using the word in a minimal context requiring the student to understand the word's meaning. The comprehension strand has two texts for off-line reading. Each contains 150 passages. After reading the text passages, students respond to computer presented questions. Teachers have the option of assigning neither or both strands.

The "Adult Reading Skills" program may also be classified as drill and practice. It is designed around the same five strands as the "Reading, Grades 3-6" program. It begins with single sentence items and builds to five line paragraphs accompanied by sets of questions in Strands C and D. The subject matter is oriented toward young adults, and much of it deals with consumer education.

"Reading for Comprehension" and "Critical Reading Skills" are new programs. The former is designed to provide ten minutes of drill and practice daily for grade levels 3.0 to 6.9. It emphasizes content area vocabulary (approximately 300 words per grade level) and paragraph reading, requiring more discrimination in choosing answers than its predecessors. The latter program ("Critical Reading Skills") is for students reading above sixth reader level. The program concentrates on vocabulary development and comprehension through off-line reading of passages in a text written to accompany the computer program.

Although not yet in use at the time of this writing, a CAI program in reading is being developed by WICAT. This program will be written in basic language for delivery by microprocessors in the $3,000-$6,000 price range (1977 prices). Programs such as this one should make CAI reading available at a much more nominal cost than has been the case for school systems other than very large ones.

In computer managed instruction (CMI), a large number of options have become available to school personnel. AIMS (Automated Instructional Management System) was developed by the New York Institute of Technology. CAM (Comprehensive Achievement Monitoring) was jointly developed by Stanford University and the University of Massachusetts. IMS (Instructional Management System) was jointly developed by the Systems Development Corporation and the Southwest Regional Laboratory for Educational Research and Development. TAG (Teachers'

Four components are common to these CMI programs. Each contains a description of the instructional sequence or course of study, frequent tests based on performance objectives, computer scoring and reporting, and computer made prescriptions. CAM and IMS require the definition of very small objectives and the testing of pupils as often as twice a week. Similar to CAM and IMS in this respect are PREP, of General Learning Corporation; TIES (Total Information for Educational Systems), a computer network of Minnesota High Schools; and SPPED (System for Program and Pupil Evaluation), of the New York State Education Department. TAG emphasizes the careful coding of materials to tested objectives so that teachers can easily retrieve the prescribed materials for assignment to their pupils.

A CMI program slightly different from the others is PLAN (Program for Learning in Accordance with Needs), developed by the American Institute for Research, Westinghouse Learning Corporation, and several participating schools. PLAN allows the learner to choose from a "menu" of activities prescribed by the computer.

PLAN is marketed by Westinghouse Learning Corporation of Iowa City, Iowa. The basic organizational component in PLAN is the TLU ("Teaching Learning Unit"), which includes objectives, activities to meet the objectives, and tests to determine whether objectives have been met. Completing a TLU usually takes two to three weeks. Students can choose the order in which they do the activity within a TLU.

The activities are presented in materials listed in *The PLAN Materials List: Levels 1-8*, published by a variety of publishers. These materials are prescribed as part of TLU's recommended by computer printouts which teachers receive every morning. At the end of each day, pupils fill out cards indicating where they are in their present TLU. This enables the computer to batch process the data overnight and provide the teacher with a complete report on each pupil's progress, the materials and activities of the day, test results, and names of students needing special attention. The aim is to allow teachers more time for individualized instruction by providing computerized clerical work.

The central computer, an IBM 370/155, is located in Iowa City. Most schools subscribing to PLAN have terminals capable of reading cards marked by students and of printing out the computerized prescriptions and summaries. In 1970, some 30,000 pupils in 79 schools were involved. Data for more recent years have been unavailable.

A CMI program similar to PLAN is LMP (Learning Management Program) marketed by the Learning Unlimited Corporation of New

Canaan, Connecticut. To enter the program, the student takes a diagnostic test which is mailed to the nearest data processing center. There the test is computer scored and a prescription is mailed back to the school on the next day. This prescription names a sequence of modules which the student is to complete at his own speed. If the school has a computer terminal, an interim (abbreviated) prescription will be available 24 hours after he takes the test. This prescription is to be followed until the detailed prescription arrives.

Each module has pretests, posttests, and progress check tests. The teacher decides whether (and when) to give the tests. A student who scores less than 80 percent on a pretest earns an *E* and enters the module. If he scores 80 percent or more, he earns an *NM* and proceeds to the next module. After he has completed some of the work in the module, the teacher may give him a progress check test which is a minitest for informal progress assessment. When the student has completed all the lessons in a module, or when he challenges, he is given the posttest, which is then scored by school personnel. Results are mailed to the LMP data processing center where weekly or biweekly reports are printed out and sent to the schools.

The materials listed in the prescriptions have been selected from a variety of publishers and some have been developed for LMP by Learning Unlimited. On the prescription sheet, modules are listed by an LMP identification number. Working in a reading laboratory or reading center, students find a Module Plan sheet or booklet which lists several materials and some activities (usually questions to be answered) to be completed with each of these materials. They contract with their center teacher to accomplish a module in a certain time period and may be awarded points for succeeding.

Another CMI program similar (and, in fact, adapted from) PLAN is TRACER, implemented in Jordan, Utah, Schools in 1977-1978 with the services of WICAT and support from Title IV ESEA. This project, involving 250 teachers, had not yet been reported in print at the time of this writing.

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322. Flanagan, J.C. *The role of the computer in PLAN.* Washington, D.C.: American Institutes for Research, 1970.
Describes computer management of educational activities.

323. Follettie, J.F. *Achievement information monitoring in schools (AIMS): Larger straws in the winds of change.* Professional paper Number 36. Los Alamitos, California: Southwest Regional Educational Laboratory, 1976.
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324. *Language arts materials catalog, school year 1977-1978.* New Canaan, Connecticut: Learning Unlimited, 1977.
A list of materials needed to implement LMP in a school. Prices and suggested quantities are listed and each item is ranked as strongly or mildly recommended consumable or nonconsumable.

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A list of locations of the various PLAN programs in four subject areas.

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Includes description of a pilot CAI project in which delinquent and predelinquent youths, aged 12-16, learned from CAI for an hour daily for 18 weeks. Those succeeding in using CAI became the tutors who helped new students learn to use the equipment. Attendance, grades, and reading scores increased while vandalism decreased.

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Manufacturers of Computers

Manufacturers of computers make every effort to assist their buyers in making maximum application of their hardware. Control Data Corporation markets the complete PLATO IV program which includes both the necessary hardware (central processor, interface, terminals, and adjunct devices such as printers, random access audio devices, touch panels, and microfiche projectors) and the software (developed at the University of Illinois, the University of Delaware, and the University of Ottawa and field tested by Florida State University).

Sperry Univac has developed curricula for schools for the deaf, using its own author language, ASET. The MITRE Corporation, in cooperation with Brigham Young University, has developed TICCIT (Time Shared, Interactive, Computer Controlled, Information Television) which is now in use at Phoenix Community College and at the Alexandria campus of Northern Virginia Community College (both are demonstration sites).

Hewlett-Packard publishes a newsletter for its Users Group who share ideas and applications about educational computing. In addition, the company maintains the HP Contributed Program library (in five volumes) which contains more than 500 education programs, some of which are for reading and/or vocabulary development. Hewlett-Packard markets Adult Skills programs leading to the General Educational Development (GED) Curriculum which is preparation for the GED High School Equivalency Examination.

The HP Adult Reading Skills program is very similar to that marketed by the Computer Curriculum Corporation. It has the same five strands, the same random selection of items at a given level within a strand, and the same standards for moving from one level to another. One difference is that the classes of items within each strand are not identical.

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350. Jones, M.C. *TICCIT mailbox communication.* McLean, Virginia: Hazeltine, 1976 (b).
351. Passman, B.M. Personal communication. May 12, 1977.
352. Rahmlow, H.F. *Use of student performance data for improvement of individualized instructional materials.* Proceedings of a symposium. Washington, D.C.: American Psychological Association, 1969. (ED 032-792)
353. Rappaport, W. & Ojenbush, E. *Tailor made teaching through TICCIT.* Bedford, Massachusetts: Mitre Corporation, 1975.

Chapter 6

RECOMMENDED USES OF COMPUTERS IN THE READING PROGRAM

Numerous suggestions for using computers to improve reading instruction and reading achievement are found in the literature of computer assisted and computer managed instruction. Many of these suggestions have been put into practice and verified on a small scale as part of one or another research project. For example, computers have already been used to diagnose reading problems and prescribe remedial materials. Furthermore, computers have already been used to generate word lists, to record words dictated by children being taught with the language experience approach, and to model the reading process.

In this chapter, many additional uses of the computer are advanced. Among these are motivational games, simulation of the informal reading inventory, test generation from an item bank, and translation of print into braille. These have not only been proposed but also have been accomplished. Also described in this chapter is a national system for keeping educational and medical records for children of migrant workers.

Annotated References

354. Ahl, D. Computers in language arts. In O. Lecarme and R. Lewis (Eds.), *Computers in education*. Amsterdam: North-Holland Publishing, 1975.

Recommends computer aided writing stimuli which generate highly motivating reading matter. Describes BUZZWORD (1 and 2), MADLIB (1 and 2), and the writing of poetry by computer.

355. Burns, E. Simulating psychoeducational data. (ED 124-109)

Describes a computer program written in FORTRAN IV to simulate data in reading and three other areas and enhance the user's diagnostic skills.

356. Davison, F.C. The state of the university address. *Columns*, 1977, 5, 3-6.

Reports availability, at the University of Georgia, of computer programs which translate print into braille.

357. Johnson, D.B. Computer frequency control of vocabulary in language learning reading materials. *Instructional Science*, 1972, *1*, 121-131.
Proposes a set of frequency groups and an algorithm for making frequencies with an IBM 360 computer. Gives a sample of the technique applied to a Russian textbook.

358. Kinkaid, J.P. Use of the automated readability index for evaluating peer-prepared materials for use in adult reading education. Statesboro, Georgia: Georgia Southern College, 1973. (ED 068-814)
The automated readability index (ARI) was used to create three versions (each at a different reading level) of stories dictated by black adults. The two easier versions were readily comprehended by high school remedial reading students. Graduate students in reading and black trainees in a funded project rated the stories as being highly interesting.

359. Lerner, J.W. *Computer simulation: A method for training educational diagnosticians.* Paper presented at the annual conference of the International Reading Association, Atlantic City, April 1971.
Northwestern University created a computer simulation of a learning disabled child for presentation at staff meetings. A pilot study concluded that the procedure was a promising method of training specialists in the diagnostic teaching process.

360. Miller, W. How the MSRTS contributes to the educational continuity of the migrant child. In J.P. Nix, H.B. Bullock, & S. Underwood (Eds.), *Proceedings of the Fifth Annual Eastern Stream Conference on Migrant Education.* Atlanta: Georgia State Department of Education, 1974.
Points out that 8,000 school districts are attached to 137 MSRTS terminals in 44 states and that 90,000 children are on the inactive lists at the data bank. Enters a plea for teachers to continue to feed in student data and make use of the system.

361. Pfiel, M.P. New data processing network tracks child's full scholastic and health history. *American Education*, 1970, *6* (5), 4-6.
Describes the Migrant Student Record Transfer System (MSRTS) then operational in seven southern and western states and being readied for use in more states. Funded by a portion of the 1969 Title I migrant projects appropriation, the computer bank employed is that of the University of Arkansas Medical Center. Eighteen terminals were connected in 1970 and a total of 300 were anticipated by 1971. When migrant children entered a participating school, the school secretary could call the terminal operator using the student's ID number and request such things as the student's reading and math levels and any chronic ailments.

362. Plattor, E.E., & Woestehoff, E.S. *The application of computer technology to education diagnosis.* Paper presented at the annual conference of the International Reading Association, Boston, April 1968.
Details seven steps in employing the computer for educational diagnosis: 1) identifying categories requisite to educational diagnosis,

2) specifying category variables, 3) selecting instruments, 4) organizing data storage, 5) developing a computer program library to execute diagnostic procedures, 6) specifying data presentation format, and 7) translating data into instructional sequences.

363. Roe, M.H., & Aiken, R.M. A CAI simulation program for teaching IRI techniques. *Journal of Computer Based Instruction*, 1976, *2*, 52-56.

A computer simulated workshop (RDLAB) was used to teach informal inventory (IRI) techniques to college students. First the computer simulated an instructor, guiding students in constructing an IRI. Then it simulated both a pupil to be tested with the IRI and the instructor guiding the student in assessing the simulated pupil.

364. Shoemaker, D.M., & Osburn, H.G. Computer aided item sampling for achievement testing: A description of a computer implementing the universe defined test concept. *Educational and Psychological Measurement*, 1968, *29*, 165-172.

Describes the creation of a set of tests for repeated measures by sample from a large body of test items.

365. Troxel, D.E. Automated reading of the printed page. *Visible Language*, 1971, *5*, 125-144.

Explains automated reading in print leading to character codes which can be processed to produce braille, spelled speech, or synthesized speech.

366. Venezky, R.; Bernard, L.; Chicone, S.; & Leslie, R. *On-line diagnosis of reading difficulties*. Technical report Number 327. Wisconsin Research and Development Center for Cognitive Learning. Madison, Wisconsin: University of Wisconsin, 1975.

Reports on a diagnostic system using a PLATO terminal with a touch panel and a random access audio device. The first program (WORD) is a control program to monitor the system. The second program contains an on-line version of the comprehension subtest of the Stanford Diagnostic Reading Test, Level II, Form W. The third program is for processing multiple-choice tests. The system was intended for eventual use in mobile vans which would visit schools to provide reading diagnosis through terminals connected to central processing units (computers) by telephone lines.

Chapter 7

COMPUTERS IN READING RESEARCH

While many of the computer based programs have been subjected to field testing with the pupils for whom they were designed, a limited number of investigations have carefully compared the reading achievement of well-defined groups of subjects whose instruction was computer assisted or computer managed. Most of the investigations listed in this chapter are one of a kind, however. Consequently, all will be annotated as they are presented, in three major sections: pupil attitudes and achievement, components or oral and printed language, and models of the reading process.

Pupil Attitudes and Achievement

Included in this section is research on the effectiveness of computer managed instruction and feedback of reading progress information to teachers. Also included is research using the computer to analyze eye movements in reading, to diagnose children's reading needs before prescribing remedial reading instruction, and to classify children as normal or dyslexic. Other investigations annotated in this section involve the assessment of student attitudes toward CAI; the prediction of science achievement from CAI word learning rate; the improvement of vocabulary, comprehension, and/or study skills; and the identification of problems in integrating CAI into the school curriculum.

Annotated References

367. Aaron, R.L., & Muench, S. The effects of a computer managed, individualized treatment program on the achievement of behaviorally disordered, delinquent adolescents. *Reading Research Quarterly*, 1974-1975, *10* (2), 228-243.

When delinquents in a Georgia Youth Development Center were randomly assigned to experimental or control groups, the experimental groups (N = 36) earned significantly greater scores in reading

and comprehension. This experimental group was taught with PLAN, a computer managed reading and mathematics program developed for the Westinghouse Learning Corporation.

368. Adams, D.P. *Effect of comprehensive achievement monitoring on student teaching.* Paper presented at the annual meeting of the American Education Research Association, Washington, D.C., March 1975.

Found no significant differences in reading achievement for students taught with the Comprehensive Achievement Monitoring (CAM) system and a control group. This finding was true for both standardized and criterion referenced measures.

369. Anelli, C.M. *Optimum length of computer assisted instruction for urban third and fourth grade reading programs.* Unpublished doctoral dissertation, Rutgers University, 1977.

Third grade girls made more gains than third grade boys when all received CAI (a drill and practice program) in reading as a supplement to their classroom instruction. Boys made better gains with 40 minute sessions than 20 minute sessions. Girls gained more than boys with both session lengths. Students receiving three to four hours of CAI in a three month period made the greatest progress per unit of time spent. CAI enthusiasm, while of considerable magnitude, decreased after seven or eight hours of machine instruction.

370. Caldwell, R.M. *A comparison of a programed text and a computer based display unit to teach reading skills to semiliterate adults.* Unpublished doctoral dissertation, Pennsylvania State University, 1973.

Young adults spent more time at the computer terminal than a comparable group spent at programed reading texts. The attitudes toward reading of the CAI taught group were more positive than those of the group taught with programed texts. However, there were no significant differences in reading achievement between the two groups.

371. Fey, T.F. *A comparision of computer and teacher prepared individualized reading prescriptions.* Unpublished doctoral dissertation, University of Florida, 1974.

After fifth graders had been administered the Gilmore Oral Reading Test, selected items from the Prescriptive Reading Inventory (McGraw-Hill), and an interest inventory, a group of classroom teachers and a group of reading teachers picked books and remedial materials which should be prescribed for each pupil tested. A computer program also prescribed from these same data. The computer generated prescriptions more closely paralleled prescriptions determined by a panel of experts than did the prescriptions written by either group of teachers.

372. Green, D.R., Henderson, R.L., & Richards, H.C. *Learning to recognize words and letters on a CAI terminal.* Paper presented to the annual conference of the International Reading Association, Boston, April, 1968.

Three experiments with four-year-old deprived children are reported. Using an IBM 1050 AV computer system, words were projected on a screen. The subjects were to hit a key upon which the word was printed. When they did so, they were told they were correct and were shown a picture of the word. After ten minutes daily for seven days,

boys matched words better than girls. In a later experiment with a similar population, the authors found no difference in numbers of matches between a group taught to match letters and a group taught to match words. In a third experiment, the authors found that young middle class children learned through CAI to match letters faster than disadvantaged children.

373. Hansen, D.N. *Application of computers to research on instruction.* Paper presented at a meeting of the National Society of College Teachers of Education, Chicago, February 1966.

Reports three studies. The first found a trend toward correct modeling after twelve second graders had received eleven CAI lessons in remedial reading. The second dealt with solving the problem of integrating CAI (spelling) with the existing curricula in a school. The third described results of teaching spelling of part of a list of words as opposed to teaching the whole list.

374. Hendon, C.A. *A comparision of reading and vocabulary achievement of elementary students taught with two reading teaching methods.* Unpublished doctoral dissertation, University of Kansas, 1976.

Compared test results of basal reader instruction to forty classes with results of same instruction supplemented with computer managed teacher support system to forty classes the following year. Results favored the basal reader instruction without computer managed support.

375. Martin, J.G., & Meltzer, R.H. Visual rhythms: Report on a method for facilitating the teaching of reading. *Journal of Reading Behavior*, 1976, *8*, 153-160.

Reports an experiment with video presentation of printed syllables on the CRT screen simultaneously with the oral pronunciation of that syllable so that sentences appear syllable-by-syllable from left-to-right on the screen. The authors think it would help the deaf.

376. Mathis, A., Smith, T., & Hansen, D.N. College students' attitudes toward computer assisted instruction. *Journal of Educational Psychology*, 1970, *61*, 46-51.

College students were pretested on attitudes toward CAI, then assigned either outside reading or 45 minutes of computer assisted instruction. Students were found to have positive attitudes which became more positive after CAI instruction, especially if they made few errors during instruction.

377. Okey, J.R., & Majer, K. Individual and small group learning with computer assisted instruction. *AV Communication Review*, 1976, *24*, 79-86.

Undergraduate students studied Bloom's mastery learning strategy at the PLATO IV terminal. Some studied alone and some studied in pairs, trios, or groups of four. Groups selected one of their number to respond by using the keyboard. There were no differences in achievement, but pairs took more computer time than single students or groups of three or four. This time seemed to have been used for discussion of concepts presented.

378. Rankin, E.F., & Bryant, P.G. Use of prediction equations and com-

puter simulation for identifying preferred sensory modality for training in reading. In G.H. McNinch, and W.D. Miller (Eds.), *Reading, Convention and Inquiry. 24th Yearbook of the National Reading Conference.* Clemson, South Carolina: National Reading Conference, 1975.

Computer simulations helped identify low achieving children whose modality preference might indicate one or another method of instruction.

379. Redfield, D.D., Donlon, B.A., & Teates, T.G. *CAI word rate: Student ability as predictors of achievement.* Technical Report Number 2, Intermediate Science Curriculum Study. Tallahassee, Florida: Florida State University, 1971.

Two measures of reading, word reading rate and word rate stability, were the best predictors of science achievement by seventh grade students bring taught science by CAI.

380. Robbins, W.E., & Tharp, A.L. A natural language computerized instruction system for elementary education. *Educational Technology*, 1976, *13* (3), 32-35.

This was an experiment to determine if a computer without teacher supervision or intervention could accept student input and satisfy student questions. The students could ask the computer questions about local geography and history. The approach enabled the students to gain local history and geography faces (including reading practice) through computer tutoring.

381. Sklar, B. *A computer classification of normal and dyslexic children using spectral estimates of their electroencephalograms.* Unpublished doctoral dissertation, University of California at Los Angeles, 1971.

Using the computer, twelve dyslexic children were differentiated from thirteen normal age and sex-matched children based on spectral estimates of their EEG readings. The greatest differences were in the parieto-occipital region during rest with eyes closed.

382. Strang, H.R. The automated instruction of practical reading skills to disadvantaged sixth grade children. *Improving Human Performance*, 1975, *4*, 43-52.

Sixth graders were pretested on such reading skills as using a telephone directory and locating topics in an encyclopedia. Then nineteen students were given CAI in some twenty-four of the skills. Posttests favored experimental subjects who learned not only the twenty-four skills taught but also several that were not taught.

383. Thompson, M.D., Jr. *The effects of spelling pattern training on the spelling behavior of primary elementary students: An evaluative study.* Unpublished doctoral dissertation, University of Pittsburgh, 1976.

Ten experimental second grade subjects were given CAI sound-letter correspondence training for twenty-four to thirty-five minutes, three times weekly for a school year. The on-line CAI work was supplemented with workbook pages. Experimental subjects outperformed control subjects on all posttests, one of which was a test of ability to read whole words. The author suggested that CAI in sound-letter correspondence might be an excellent supplement to the reading program.

384. Wadham, R. *Monitoring reading instruction through the use of a microcomputer.* Paper presented at the Rocky Mountain Regional Conference of the International Reading Association, Salt Lake City, October 1977.

Described preliminary research done in connection with the development of TICOR (Timed Interval Categorical Observation Recorder), a small suitcase-sized device which records classroom interaction during instruction on digital tape. Both the order and the duration of instructional events are recorded for computer analysis.

385. Wadham, R.A., et al. *An elementary education project for the evaluation of teacher effectiveness.* Provo, Utah: Department of Elementary Education, Brigham Young University, 1977.

Proposal submitted to the Research Division and BYU Research Support Program for funded support in extending and expanding the area of research activity related to the senior author's current TICOR research.

Components of Oral and Printed Language

In this second section is research which sought to find elements of spoken and/or written language which, when listed or categorized, would facilitate teaching reading. Included are studies in which computers generate wordlists for instruction, studies in which computers count phoneme-grapheme correspondences or evaluate variations in initial consonants on these correspondences, and studies attempting to generate more readable written text or to edit existing text.

Annotated References

386. Carver, R.P. *New techniques and improving reading comprehension.* Technical Report Number 1. Silver Spring, Maryland: American Institute for Research in Behavioral Sciences, 1973.

Details a computerized method for converting prose training materials into different form which forces trainees to read at some specified minimum level of comprehension.

387. Cronnell, B. *Designing a reading program based on research findings in orthography.* Report Number PP-14. Inglewood, California: Southwest Regional Educational Laboratory, 1972.

A lexicon of primary grade words of one and two syllables were computer processed, determining 166 spelling-to-sound correspondences requisite for beginning reading. Six thousand words were coded by their spelling-to-sound correspondences and then arranged in a sequence for instruction.

388. Durr, W.K. *A computer study of high frequency words in popular trade juveniles.* Paper read at the annual conference of the International Reading Association, Anaheim, May 1970.

A computer analysis of 105,280 words printed in 80 primary texts

selected by teachers and librarians found 3,220 different words. Ten words accounted for one-fourth of the running words, 25 accounted for one-third, and 188 accounted for 70 percent.

389. Schallert, D.L. *Empirical investigations of the effects of differences between oral and written language on comprehension.* Paper presented at the annual meeting of the National Reading Conference, New Orleans, December 1977.

Describes effects of differing segmentations on children's abilities to comprehend and follow directions delivered by a PLATO terminal.

390. Pennock, C.D. Quick word lists for Canadian readers. *Alberta Journal of Educational Research*, 1974, *20*, 8-14.

Described computer processed word lists and derivatives which might supplement or replace older lists such as the Dolch Sight Word Vocabulary List.

391. Seigel, A.I., & Wolf, J.J. Computer analysis of textual comprehensibility. In O. Lecarme and R. Lewis (Eds.), *Computers in Education*. Amsterdam: North Holland Publishing Company, 1975.

Describes mechanization via computer of text analysis to determine comprehensibility measures. Names groups involved in developing computer response mechanisms for questions phrased in "Natural Language" (English). At the time of writing, eleven measures of comprehensibility were possible: 1) Guilford's "Cognitive of Semantic Units," 2) evaluation of symbolic implications, 3) cognition of figural units, 4) convergent production of semantic systems, 5) cognition of semantic relations, 6) convergent production of semantic implications, 7) divergent production of semantic units, 8) transformational complexity, 9) Yngve depth, 10) morpheme depth, and 11) self-embeddedness.

Models of the Reading Process

This third section includes research in which computers are used to evaluate models of the reading process or to assess components of the process of comprehension.

Annotated References

392. Collins, A.M., & Quillian, M.R. Experiments on semantic memory and language comprehension. In L.W. Gregg (Ed.), *Cognition in learning and memory*. New York: John Wiley and Sons, 1972.

Describes a computer program which comprehends printed text by comparing it to a memory bank of stored factual semantic information.

393. Hawley, T.T.; Stern, J.A.; & Chen, S.C. Computer analysis of eye movements during reading. *Reading World*, 1974, *13*, 307-317.

Describes computer analysis of electrically recorded eye movements during reading. Five were identified as qualitatively and quantitatively different from the usual saccadic movements.

394. Herndon, M.A., & Bowen, D. *Evaluation of two pattern recognition algorithms for computer models of reading behavior.* Paper presented at

the National Reading Conference, St. Petersburg, Florida, December 1975.

As part of any computer model of reading behavior; one must develop pattern recognition (identifying strings of letters and words as matches to similar patterns stored in memory). The authors tried two algorithms, deciding that the first was more sensitive and that the second was more economical.

395. Rumbaugh, D.M.; von Glaserfeld, E.; Warner, H.; Pisani, P.; Gill, T.; Brown, J.; & Bell, C. A computer controlled language training system for investigating the language skills of young apes. *Behavioral Research Methods and Instrumentation*, 1973, *5* (5), 385-392.

Describes the 46 classes in the YERKISH computer language and the electromechanical system devised for Lana (the chimp) to learn and use.

396. Rumbaugh, D.M.; Gill, T.V.; & von Glasersfeld, E. Reading and sentence completion by a chimpanzee, *Science*, 1973, *182*, 731-733.

A report of the linguistic skills acquired by Lana in communicating with the computer language YERKISH, named for the Yerkes Primate Laboratories.

397. Leton, D.A. *Computer program to convert word orthography to phoneme equivalents.* Final report. Honolulu: Hawaii University Educational Research and Development Center, 1970. (ED 038-266)

This report describes computer simulation of reading skill acquisition. The research aim was to convert orthography of English words to phoneme equivalents for computer programing. The conversion was done at the preprimer and primer levels of the Lippincott basal series. The results are included.

398. Leton, D.A. *Computer simulation of reading.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, April 1972.

Computer simulation allows a detailed and complete study of the acquisition of reading skills. The program, called SIMUREAD, converts English orthography to segmented phonemes, which in turn are simulated by numerals.

399. Leton, D.A. Computer simulation of reading: A progress report. *Journal of Reading Behavior*, 1974, *6* (2), 131-141.

The article describes SIMUREAD, a computer program which is designed to aid in reading instruction and clarify its research applications.

400. McKenna, M.C. *Computer simulation of cloze performance.* Paper presented at the National Reading Conferenoe, New Orleans, December 1977.

Using PL/1, a language with good verbal capacity, a computer memory was programed to search wordlists for words appropriate for one, two, or three constraints. The computer search time was parallel to human response time to cloze responses with one to three constraints per word.

401. *Visual search activity: A tool for the evaluation and development of computer assisted reading instructional programs.* Annual report, Behavior Research Laboratory. St. Louis: Washington University, 1975. (ED 112-362)

Eye movements of readers reading from the plasma panel of a PLATO terminal were analyzed by computer. Competent readers made fewer saccadic movements per line and had shorter fixation times. When reading for detail, competent readers changed only by increasing their fixation times. Less competent readers made more fixations when reading for detail. The authors suggest that the long lines of print make readers less efficient in reading the PLATO display than in reading books.

402. Wisher, R.A. *Linguistic expectations and memory limitations in reading.* Paper presented at the annual conference of the International Reading Association, Miami Beach, May 1977.

Subjects pressed buttons to cause a computer terminal to display each phrase they were to read. Average phrase reading time was computed in milliseconds. Fast college level readers appeared to prefer using semantic clues when syntactic features are known before reading. Average readers seemed to prefer to use both semantic and syntactic clues to meaning.

403. Wisher, R.A., & Aiken, E. *Information overload during reading.* Paper presented at the National Reading Conference, New Orleans, December 1977.

Computer timed tones were sounded at certain points during fixations by navy trainees reading from a college reading improvement text. By analyzing 12,000 eye movements interrupted by tones, authors determined that information learned during a fixation (while reading) is transient up through 100 milliseconds.

404. Wisher, R.A. *Improving language skills by computer.* Paper presented at the annual conference of the Association for the Development of Computer Based Instructional Systems, February 1978.

Reviews and illustrates what the computer offers in the field of language arts and highlights several programs under development at the Navy Personnel Research and Development Center in San Diego.

Chapter 8

THE FUTURE OF THE COMPUTER AS AN AID TO READING INSTRUCTION

In the process of completing this book, the authors read numerous reports, articles, books, and reviews. It was readily apparent that the vast majority of computer based education projects were in mathematics or applications of mathematics (economics, bookkeeping, and statistics), or in physics, chemistry, and the other sciences. Fewer were in the humanities, and comparatively few were in reading.

There seem to be several reasons for this inequality. One is that the original purpose of computers was computation, the natural realm of the mathematician. A second reason is that CAI requires instruction to be programed and many reading specialists are averse to programing instruction. A third reason is that the less costly CAI terminals (teletypes-TTSS) require the operator or student to be able to do some reading and writing in order to use the terminal. A fourth reason is that the equipment once thought necessary for teaching beginning reading (random access audio and light pencil and/or touch panel) is complex and very expensive and was not available until the early 1960s. When it became available, reading people were frequently not asked to involve themselves. In computer based education, reading specialists have been conspicuously absent.

Now, however, after a slow start, the projects and the interest are increasing. Most encouraging is the involvement of Pikulski and Pelosi (University of Delaware), Hansen and Wadham (Brigham Young University), Geoffrion (University of New Hampshire), and Kamil and his associates (Purdue University) in computerizing remedial reading, college reading, beginning reading, and inservice reading education, respectively.

Their work, and the work of other reading specialists hoping to capitalize on the capabilities of computers, will probably lead to the de-

velopment of some exciting new programs in the remaining years of this century. When coupled with the developments in computer manufacturing technology, their efforts may well lead to advances beyond our present dreams.

There is little doubt that most American homes will have microcomputers before 1990. They will be preprogramed to do such things as control the heat in the house; turn lights off and on; count calories and plan meals; store and display recipes, phone numbers, addresses, and income tax information; record favorite radio and TV shows for later viewing; play games using the TV set as a display panel; and provide academic drill and practice activities as well as do-it-yourself information.

Schools will also have microcomputers, perhaps with several terminals per classroom computer connected to a larger minicomputer which serves the entire school and which is, itself, connected to a CPU serving the school district network. The reading programs available on these computers will be as varied as the printed basal and supplementary programs available today.

When machines are put in classrooms, teachers do one of two things. They find ways to make use of the machine, or they leave the machinery to gather dust (perhaps hiding it in a closet). Just as some of today's reading teachers make use of tape recorders, slide and filmstrip projectors, and movies, so will some of tomorrow's reading teachers use computers to aid in their teaching of reading.

Some teachers will use computers to teach sight vocabulary. Children will match words and pictures on the display screen. Many teachers will use computers as diagnostic devices, allowing students to be tested on-line so that the teacher may receive an immediate estimate of instructional level and skills to be taught. Nearly all teachers will be required by their school district or system to record attendance, grades, and progress in reading on one of the terminals in their classrooms.

Books will *not* become obsolete and neither will teachers. The vacuum cleaner has not yet replaced the broom; the washer, dryer, and dishwasher have not replaced the housewife nor eliminated housework. The computer will not eliminate the need for teachers to teach. Instead, it will present much of the drill and take care of the extensive individual record keeping which is the bane of present day teachers who individualize instruction.

In the future, books frequently will be accompanied by a tape or a floppy disk upon which is printed a computer program providing testing, diagnosis and prescription, or drill and practice activities to accompany the book's content. The practice exercises may be assigned

as homework to be done with the home microcomputer. Basal reading programs will offer as options, not only the trade books, workbooks, word cards, ditto masters, and criterion referenced tests they offer today but, also, computer programs for diagnosing and prescribing using those tests and materials, as well as drill and practice programs keyed to the skills and stories contained in the printed materials.

A long sought for intercorrelation of language arts instruction will be formed by the typewriter keyboard basic to most computer terminals. As a part of playing computer games, practicing reading exercises, and solving mathematics problems, pupils will learn to write and spell (within the contexts allowed by the programs to which they are exposed) the words and sentences appropriate to the games, exercises, and problems.

Some schools will provide children with personal computers. Perhaps microcomputers, similar to those already under development at the Xerox Research Center in Palo Alto, will store and present at the call of the student any information stored in their memory banks which will contain the equivalent of several thousand pages of information. With such personal computers, students will be able to access (call up) at will the equivalent of an encyclopedia of information—to create artistic creations or musical compositions impossible to produce by hand or check the spelling of words using computer stored picture dictionaries or glossaries. On personal computers, students in these schools will store their assignments and the completed work assigned. Forgetting to bring one's computer to school may become an excuse as common as "I forgot my homework," or "I left my book at Grandma's house."

In the future, the emerging interdependence of computers and instructional television may well form the basis for semiprogramed instruction daily by most Americans as well as the stop action pictures required for reading print, diagrams, and schematics.

Adult basic education, consumer education, career retraining, and do-it-yourself activities will become available on videodisc which many schools will be equipped to use. Using videodisc, the memory power of the computer, with its feedback response capabilities, can be coupled with the motivational power of television. The videodisc—a shiny, silver-colored disc that looks much like an LP record—may well come into more common use by educators than the LP records of today.

The rapid growth in technology will, of course, require software in order to generate sales of computers and computer operated equipment. Well known educators will be asked to create programs (or to

consult with computer companies) especially appropriate for computer interactive presentation. Successful printed and boxed reading instruction materials may be stored in minicomputers and made available to homebound students who dial into the school's computer so that their home computer or terminal can display the reading material and questions.

The programs stored in the memories of the various computers developed in the past twenty years of this century will be just as good and just as bad as those available in print today and educators will have to study well in order to choose wisely. One thing is sure: Educators will be bombarded by sales representatives and brochures of the type parodied in the third from the last reference for this chapter.

Annotated References

405. Bennion, J., & Schneider, E.W. Interactive videodisc systems for education. *Journal of the Society of Motion Picture and Television Engineers*, 1975, *84* (12), 949-953.
Describes how videodisc enables programers to develop interactive educational TV instruction utlizing "freeze frames," electronic address, and fast random access. The relationship of videodisc instruction to the TICCIT program is described and cost estimates are graphed.

406. Blackwell, F.W. *The probable state of computer technology by 1980.* Santa Monica: Rand Corporation, 1971.
Suggests that improved communication links, such as cable TV, can bring equal computer opportunity to children in diverse kinds of schools and at home. Simple English is predicted as a common author language.

407. Curtis, A.R. Everyman's home computer is here. *Popular Mechanics*, 1977, *148* (4), 92-93, 192.
Introduces the novice to home microcomputers and their uses, memories, and display features.

408. Elementary school sets up own minicomputer data bank. *Educational Technology*, 1970, *10* (4), 89.
Describes 35-pound minicomputer at Juliette Low Elementary School in Elk Grove Village, Illinois. This is believed to be the first elementary school computer installation in the United States. The computer has an 8,192 word memory, disk pack data storage, and input/output terminals.

409. Hardin, B., & Carroll, R. On the reading horizon. *Teacher*, 1977, *93* (5), 53-56.
A discussion of trends and how they might effect the teaching of reading. Includes computerized reading programs.

410. Hawkins, W.J. What's new in electronics. *Popular Science*, 1977, *211* (3), 104.
Describes and shows pictures of a computer device for changing the home TV into a teaching device as well as a game board, for less than $150.

411. Heuston, D.H. *The promise and inevitability of the videodisc in education.* Paper submitted to the National Institute of Education. New York: WICAT, 1977.
Describes the promise of the videodisc and methods of program authoring, makes recommendations for NIE, discusses strengths and weaknesses of various educational systems, and estimates costs required for large scale educational development.

412. Hodges, D.A. Microelectronic memories. *Scientific American*, 1977, *237* (3), 130-131, 135-136, 138-140, 142, 144-145.
Describes recent improvements in computer memory using semiconductor technology which places thousands of circuits on a tiny silicon chip. The storage possibilities of these circuits are now being increased with magnetic bubble and charge coupled devices.

413. Holton, W.C. The large-scale integration of microelectronic circuits. *Scientific American*, 1977, *237* (3), 82-94.
Reports that today's $1,000 minicomputer can very nearly equal the capabilities of the $20 million dollar computers of fifteen years ago, describes computer binary arithmetic, and gives excellent simplified diagrams of how computer circuits work. Includes some history of computer development.

414. Kay, A.C. Microelectronics and the personal computer. *Scientific American*, 1977, *237* (3), 230-232, 234, 236-242, 244.
Describes development of a notebook sized personal computer at the Xerox Palo Alto Research Center, its language (SMALLTALK—a new type language dealing with parallel messages) developed to let children and nonexpert adults write sophisticated computer programs and its tryout by 250 children (aged six to fifteen) and 50 adults. Includes the prediction that the personal computer will not revolutionize education.

415. Levien, R.C.; Barro, S.M.; Blackwell, F.W.; Comstock, G.A.; Hawkins, M.L.; Hoffmayer, K.J.; Holland, W.B.; & Mossman, C. *The emerging technology: Instructional uses of the computer in higher education.* New York: McGraw-Hill, 1972.
A detailed report to the Carnegie Commission on Higher Education that gives a nontechnical introduction to computers and their potential for college instruction, estimates the extent of their use at the time, and examines the possibilities for the future.

416. Mossman, C. *Evaluating instructional computing: Measuring needs and resources for computing in higher education.* Educom Monograph Series Number 2. Princeton, New Jersey: Educom, 1977.
Reports a 1975-1976 NSF project funded to determine computing resources for assessing college students' proficiencies, capabilities, and needs. A large part is a report of a questionnaire study of opinions of faculty, students, and staff members at the University of California at Irvine.

417. Papert, S.A., & Minsky, M. *Condon Lectures.* Corvallis, Oregon: Oregon State System for Higher Education, 1974.
Explains the LOGO program for creative programing and problem solving by children. LOGO was developed at MIT, and at Bolt, Beranek,

and Newman, Inc. Children using it create programs which generate music, make a turtle image crawl around and draw lines on the display screen, and make a robot turtle perform the same acts on the floor.

418. Ryan, M.J. Finie's great teaching machine. *Phi Delta Kappan*, 1977, 59 (2), back cover.
A satirical presentation of an imaginary computerized audiovisual teaching device using play-on-words with the specialized vocabulary of CAI and videotronics.

419. Siedel, R.J., & Rubin, M.L. (Eds.) *Computers and communications: Implications for education*. New York Academic Press, 1977.
A 428-page set of reports, predictions, and discussions of a conference sponsored by the Human Resources Research Organization (HumRRO) to provide information on computer technology in language understandable to educational planners concerned with implications for 1985.

420. Wisher, R.A. *Innovations in computer assisted instruction for reading*. Paper presented at the annual conference of the International Reading Association, Houston, May 1978.
Reviews five CAI projects examining the feasibility of teaching reading skills to differing groups of people. Includes reasons why the reading teacher must become involved in CAI and a prediction for the future of CAI in reading classrooms.